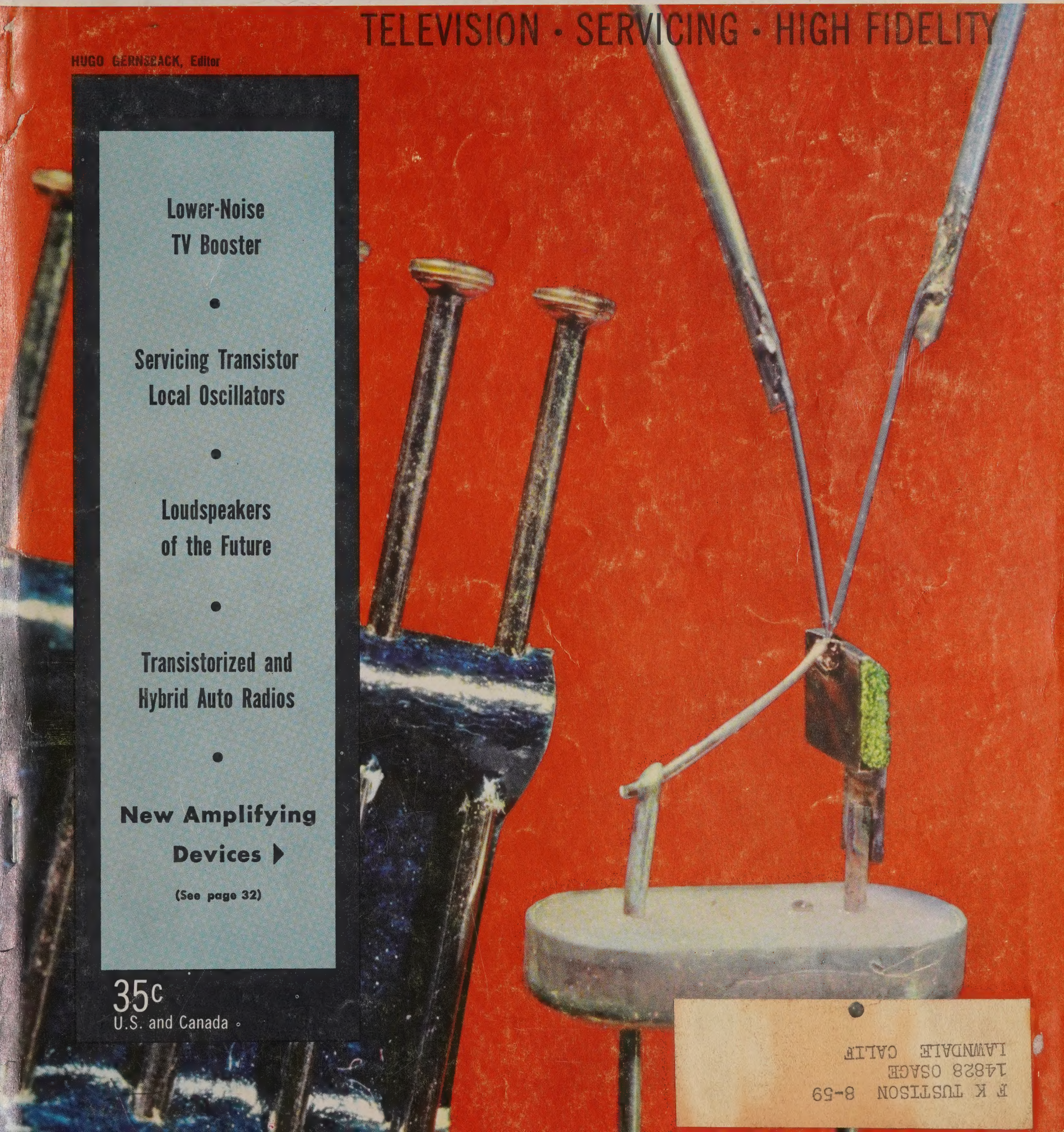
NEW! TWIN-COUPLED HI-FI AMPLIFIER

NOVEMBER 1957

Radio-Electronics

TELEVISION · SERVICING · HIGH FIDELITY

HUGO GERNSBACK, Editor



Lower-Noise TV Booster

•

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Transistorized and Hybrid Auto Radios

•

New Amplifying Devices ▶

(See page 32)

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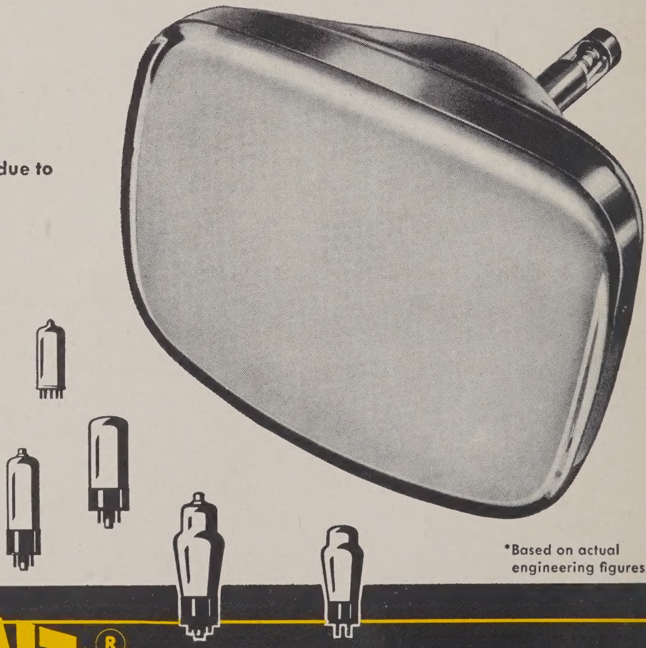

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NEXT MONTH: PHONOGRAPH PICKUP ARMS
• CARE AND MAINTENANCE OF THE VTVM

ON THE COVER

(Story on page 32)

The unusual-looking device is a Spacistor, a new type of semiconductor, expected to operate at frequencies higher than 1,000 mc. The package of pins at the left gives an idea of the unit's size.

Color original by Raytheon Manufacturing Company.

Average Paid Circulation Over 195,000

Associate Member Institute of High Fidelity Mfrs., Inc.

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News Briefs

RETMA CHANGES NAME. The Radio-Electronics - Television Manufacturers Association has changed its name to Electronic Industries Association (EIA). This is hoped to be the end of a series of changes, by which the Radio Manufacturers Association (RMA) successively became RTMA and then RETMA before adopting its present title.

2 TV PROGRAMS TO A CHANNEL, making it possible for one to be used for pay-TV and the other for free viewing, has been proposed to the FCC by Blonder-Tongue Labs. Though exact technical details are not yet available, it was revealed that two pairs of signals

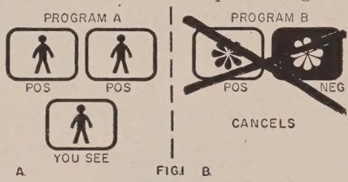

FIG.1

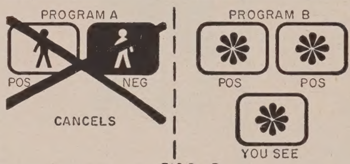

FIG.2 B

are to be transmitted by the TV station, one pair for program A and the other for program B. Program A consists of two positive units (see Fig. 1-a) which combine to produce a show on the viewer's screen. However, program B is made up of one positive and one negative signal. (see Fig. 1-b). These signals cancel each other and do not appear.

When you wish to see program B, a Bi-Tran decoding signal is fed to the receiver. The decoding signal reverses the negative image in the B program to positive and the B program is received (see Fig. 2-b). Simultaneously, one of the positive signals for the A program is reversed to negative and the A program is cancelled out (see Fig. 2-a). As applied to pay TV, the normal (free) program would come through on the A channel and the pay program on the B channel. To watch the pay program, the set would be switched to the B channel. This would bring decoding signals—carried on the regular telephone line—to the receiver, and at the same time would transmit information as to the program selected back to the telephone office. The payment could be included in the viewer's monthly phone bill.

Modification of both receiving and transmitting equipment would, of course, be necessary.

In military uses the Bi-Tran system could allow transmission of classified information as only persons who knew the proper decoding signals could decipher the signal.

Doubling the number of TV channels would also permit educational programs and public service information as required by police and fire departments and hospitals to be transmitted without disturbing any existing programs.

Calendar of Events

1957 Toronto High-Fidelity Exposition, Oct. 30–Nov. 2, Park Plaza Hotel, Toronto, Canada.
Technical Conference of IRE Professional Group on Electron Devices, Oct. 31–Nov. 1, Shoreham Hotel, Washington, D. C.
High Fidelity Music Show, Nov. 1–3, Hotel Multnomah, Portland, Ore.
International Congress and Exhibition of Measuring Instrumentation and Automation, (Interkama 1957), Nov. 2–10, Düsseldorf, Germany.
Third IRE Aeronautical-Communications Symposium, Nov. 6–8, Hotel Utica, Utica, N. Y.
Puerto Rico Hi-Fi show, Nov. 8–10, Normandie Hotel, San Juan, P. R.
High-Fidelity Music Show, Nov. 8–10, New Washington Hotel, Seattle, Wash.
Third Annual IRE Instrumentation Conference, Nov. 11–13, Biltmore Hotel, Atlanta, Ga.
EIA (RETMA) Radio Fall Meeting, Nov. 11–13, King Edward Hotel, Toronto, Canada.
New England Radio–Electronics Meeting, Nov. 15–16, Mechanics Hall, Boston, Mass.
High Fidelity Music Show, Nov. 22–24, Statler Hotel, St. Louis, Mo.
1957 Eastern Joint Computer Conference, Dec. 9–13, Sheraton-Park Hotel, Washington, D. C.
RETMA Conference on Maintainability of Electronic Equipment, Dec. 18–19, University of Southern California, Los Angeles, Calif.

NEW BATTERY makes electricity direct from gases, by feeding oxygen and hydrogen through its electrodes. The simplified diagram shows the basic operation of this new battery, called a fuel cell. Hydrogen and oxygen enter the cell through specially treated, hollow, porous carbon electrodes. When the gases diffuse to the electrodes' surfaces, they come into contact with the electrolyte, a solution of potassium hydroxide. At the hydrogen electrode, the electrochemical reaction releases an electron which flows through the external circuit and is accepted at the oxygen electrode. This flow of electrons is the current that powers electrical

(*Continued on page* 10)

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G. F. Beane, W. Virginia, was a truck driver. He took the DeVry Tech Training Program, and is now a technical electronics sales representative.

Edward Hahn, Illinois. Was a laborer, now an electronics project engineer with Televiso, Inc. DeVry Tech training helped him prepare for his present position.

Nick Barton, Illinois, came directly from high school to DeVry Tech. Now has his own service shop and tells us he is "literally snowed with work."

George D. Crouch, California, was a retail store clerk. He took the DeVry Program, and today is in the servicing field for himself.

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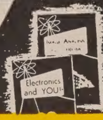

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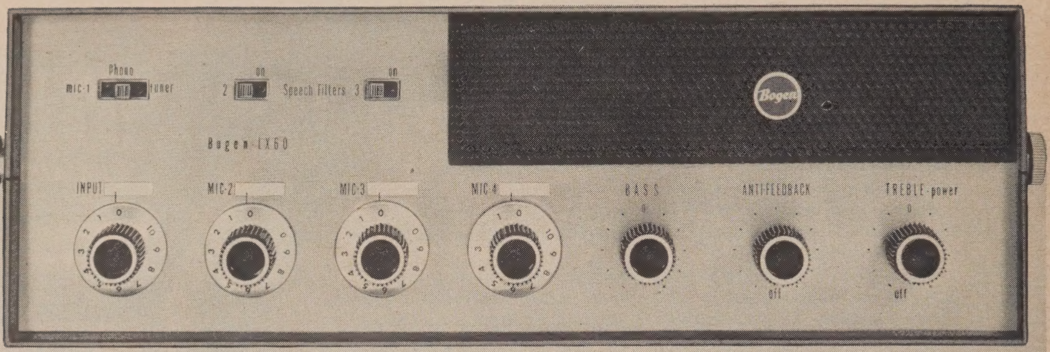

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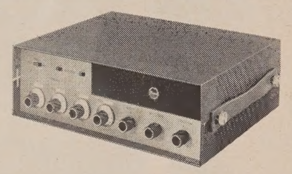
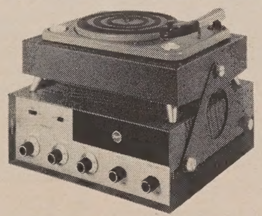


Deluxe LX30 30-Watt Amplifier

4 Microphone Inputs (panel switch converts one microphone channel for phono or tuner); Built-In Remote Gain-Control Circuit; Exclusive Anti-Feedback Control; Speech Filters; Separate Bass and Treble Tone Controls.

H. 5⅜", W. 16¼", D. 13". Wgt.: 25 lbs.



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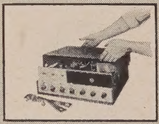
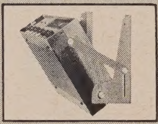
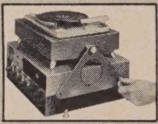


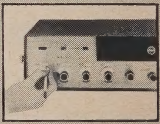
Loosen 4 thumbscrews and the lid's off for fast, easy servicing.



Folds back when not in use in easy-sliding wall-mount bracket.



4 thumbscrews attach accessory record player mount.



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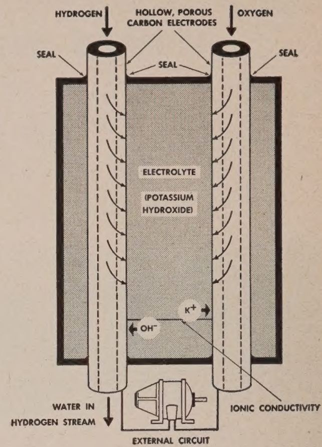

equipment. Ionic conductivity through the electrolyte completes the circuit, positive potassium ions picking up their missing electrons at the oxygen anode. Water formed in the reaction passes from the cell in the hydrogen stream. There is no deterioration of electrodes or electrolyte, and the cell can operate indefinitely as long as "fuel" (oxygen and hydrogen) is supplied to it. Research has indicated that the optimum fuel-cell design will deliver approximately 1 kilowatt from a unit 1 cubic foot in volume. Potential across the terminals is about 1 volt.

As a producer of electrical energy, the fuel cell, developed by the National Carbon Co., depends on a practical and economical source of hydrogen. This gas, at present, is expensive and requires relatively bulky containers.

AIRCRAFT COLLISION WARNING device is expected to give pilots 20 seconds' notice of impending disaster. The new detector is said to pick up infra-red radiation from a second plane 2–4 miles away. An Aerojet-operated DC-3 is scheduled to make actual air tests of the system. If the tests are favorable, airlines would probably start installing detectors by the end of 1958.

The system's operation is comparatively simple. A rotating infra-red detector scans a 360° arc around the plane horizontally. The vertical scanning arc is 150°. When another plane is detected, a light flashes on a cockpit dial and an arrow shows the direction of the intruder. Two additional detectors cover the area above and below the plane. Any intruder within 800 feet sets off a second warning, giving the pilot sufficient time to avoid an accident.

Scheduled airlines have been worried about the collision danger for two years or more. A 1955 survey showed a large number of near collisions. The Aerojet-designed system will give only limited protection against high-speed jets, and its usefulness would be confined to clear weather. Storms limit the range of the

detectors. However, a large majority of near-collisions occur in clear weather. If these could be avoided, the system would be worth while.

LESS ELECTRICITY IN THE AIR was reported by D. J. L. Koenigsfeld, director of the Magnetic Observatory of Manhay at the University of Liege in Belgium. The air 1 meter above the ground has been found in the past to have a normal potential of 100 volts in relation to the earth. Now, as measured in Belgium, it is only 15 volts.

According to Professor H. R. Byers, chairman of the Department of Meteorology at the University of Chicago, an increase in ionization of the lower part of the earth's atmosphere could create a layer of ionized air similar to the ionosphere. Such a layer might result in a new kind of radio blackout. It might also affect weather, reducing the number of lightning flashes in thunderstorms.

Whether this change in potential is part of a normal cycle or what may be causing the drop was not stated, although the suggestion was made that it could possibly be due to the injection of radioactive material into the atmosphere.

SIX NEW TV STATIONS, scattered throughout the country, started off the fall season:

WWL-TV, New Orleans, La. 4
WIIC, Pittsburgh, Pa. 11
WAVY-TV, Portsmouth-Norfolk, Va. 10
KTCA-TV, St. Paul-Minneapolis, Minn. 2
KSPR-TV, Casper, Wyo. 7
WFGA-TV, Jacksonville, Fla. 12

WENS, Pittsburgh, Pa., channel 16, quit telecasting on Aug. 31.

The following stations changed call letters since our last report:

KVIP-TV, Redding, Calif. 7
(formerly KVIP)
WKXP-TV, Lexington, Ky. 27
(formerly WLAP-TV)
WJZ-TV, Baltimore, Md. 13
(formerly WAAM)

These developments change the total figures to 508 operating U. S. stations (419 vhf and 89 uhf), 26 of which are noncommercial (6 uhf).

A FUNDAMENTAL RADAR PATENT, which gives the Government a royalty-free license, was granted to Col. William R. Blair, retired U. S. Army Signal Corps scientist.

The pulse-echo method of direction finding and ranging covered by the patent was conceived by Colonel Blair before 1930. The system was developed during the 1930's at Signal Corps laboratories at Fort Monmouth, N. J.

In early 1937, a complete, workable radar set was demonstrated for the Secretary of War and members of Congress. Due to the high degree of secrecy surrounding the development of radar, a patent application was not filed by the Signal Corps until June, 1945, and the passage of a private bill by Congress was necessary to remove the bar of late filing. END

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Gyro-like Roto-Drive gives new Thorens TD-124 absolute speed uniformity. Heavier than 16-inch turntables, yet it starts, stops in less than 2/3 turn!

How to get the heaviest possible turntable for smooth, absolutely quiet operation without sacrificing fast starts and stops.

That's the problem Thorens engineers faced when they set out to build the best four-speed, 12-inch, hi-fi turntable money can buy. You'll be amazed at the simplicity of their solution.

The new TD-124 really has two turntables in one: (1) a heavy 10-lb. rim-concentrated, cast-iron flywheel (outweighs 16″ aluminum turntables) (2) a light aluminum cover, or turntable proper. An exclusive, Thorens-originated clutch couples or decouples the light aluminum table to the heavy flywheel for instant starts and stops. What's more, the Thorens double turntable system gives you the weight of a cast-iron table (3 times as heavy as aluminum) without danger of attracting any pickup magnet. And with this unique construction, your pickup gets magnetic shielding from motor or transformer hum fields by the iron turntable.

Ask your hi-fi dealer to show you the Thorens TD-124. Better yet, arrange to hear one of those critical, slow piano records on the TD-124. If you don't know who your dealer is, write Thorens Company, Dept. E117, New Hyde Park, N. Y. 7.9

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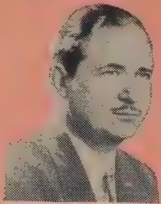

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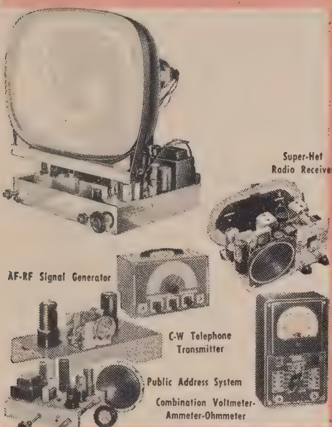
Just figure it out for yourself. There are more than 400 television broadcasting stations operating right now and hundreds more to be built; more than 34 million sets in the country and sales increasing daily. Soon moderately priced color television sets will be on the market and the color stampede will be on.

All these facts mean that good jobs will be looking for good men. You can be one of those men if you take advantage of my training *now* — the same training that has already prepared hundreds of men for successful careers in the radio-television-electronics field.



LEARN BY DOING

RADIO-FM-TV TECHNICIAN TRAINING

No experience necessary! You learn by practicing with professional equipment I send you. Many of my graduates who now hold down good paying technician jobs started with only grammar school training.

FM-TV TECHNICIAN TRAINING

If you have previous Armed Forces or civilian radio experience you can finish your training several months earlier by taking my FM-TV Technician Course. Train at home with kits or parts, plus equipment to build YOUR OWN TV RECEIVER. ALL FURNISHED AT NO EXTRA COST!

After you finish your home study training in the Radio-FM-TV Technician Course or the FM-TV Technician Course you get two weeks, 50 hours, of intensive Laboratory work on modern electronic equipment at our associate school in New York City, Pierce School of Radio & Television.

COLOR TV TECHNICIAN COURSE—All new! Learn the latest. Be prepared for those Color TV servicing profits ahead! Contains the most up-to-date servicing data, procedures and circuits. For men with radio or TV training or experience.

Sylvania Now-Sponsoring RTTA's Color TV Technician Course
One of the nation's largest electronics manufacturers and marketers Sylvania Electric Products Inc. in its continuing effort to cooperate with independent service dealers is now sponsoring the RTTA Color Television Technician Course. Available to Authorized Sylvania Dealers.

VETERANS!

My School fully approved to train Veterans under new Korean G. I. Bill. Don't lose your school benefits by waiting too long. Write discharge date on coupon.

As part of your training I give you the equipment you need to set up your own home laboratory and prepare for a BETTER-PAY TV JOB. You build and keep an Electromagnetic TV RECEIVER designed and engineered to take any size picture tube up to 21-inch, (10-inch tube furnished. Slight extra cost for larger sizes.) . . . also a Super-Het Radio Receiver, AF-RF Signal Generator, Combination Voltmeter-Ammeter-Ohmmeter, C-W Telephone Transmitter, Public Address System, AC-DC Power supply. Everything supplied, including all tubes.

EARN WHILE YOU LEARN Almost from the very start you can earn extra money while learning by repairing radio-TV sets for friends and neighbors. Many of my students earn enough each week to pay for their entire training from spare time earnings . . . start there own profitable service business.

FCC COACHING COURSE Qualifies you for Higher Pay! Given to all my students AT NO EXTRA COST. Helps you qualify for the TOP JOBS in Radio-TV that demand an FCC license! Full training and preparation at home for your FCC license.

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Dept. RE-11D, 52 East 19th Street, New York 3, N.Y.
Dear Mr. Lane: Send me your NEW FREE BOOK, FREE SAMPLE LESSON that will show me how I can make TOP MONEY IN TELEVISION. I understand I am under no obligation.

(PLEASE PRINT PLAINLY)

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Address____________________

City____________ Zone____ State______

☐ Color TV Technician Course
☐ Radio-FM-TV Technician Course
☐ FM-TV Technician Course
☐ TV Studio Technician Course

VETERANS! Write discharge date

Correspondence

BETTER BASS—CORRECTION

In my article "Better Bass Response," published in the September issue, I stated (page 34) that the flare cutoff of the Klipschorn is about 50 cycles. I was mistaken — the K-horn uses a 40-cycle flare.

One other statement in the article may be misleading to some readers. The sentence reads, "Below its cutoff frequency, a horn acts as a mass coupled to the driver cone." This is quite true — it acts as a mass coupled to the cone *as well* as retaining to some degree the resistive characteristic of horn loading. In other words, a finite horn of fairly large throat area does not abruptly unload its driver at cutoff frequency. The transition is more gradual than graphs based on theoretically infinite horns indicate. Moreover, the throat impedance of such a horn *never* reaches zero, but approaches a small finite value.

I should perhaps have made this point more emphatically in the article. Unfortunately, to go into an explanation of the various factors involved in the performance of various commercial horn designs below theoretical flare cutoff would require a separate article.

GEORGE L. AUGSPURGER
Los Angeles, Calif.

HORN CUTOFF

Dear Editor:

This concerns Mr. Augspurger's article in the September issue and his letter of correction.

I'd like to point out that the horn has a property of unloading gradually, rather than abruptly at the so-called cutoff point. My paper "A Note on Acoustic Horns" (*Proceedings of the IRE*, Vol. 33, No. 17, pages 447-49, July, 1945) shows the actual throat impedance, both resistive and reactive components, to be continuous and finite through the point of cutoff.

Actually, the useful impedance of a horn can be made available down to about 80% of the cutoff frequency. Thus in our Klipschorn, referred to by Mr. Augspurger, the design cutoff due to taper is 40.5 cycles, calculated on the shortest length of a string stretched from throat to mouth. Taking the mean path, the taper cutoff calculates to about 37 cycles. The response is down 10 db at 32 cycles (relative to 100 cycles) so 32 cycles is taken as the practical cutoff, though wave propagation and sound pressure are still being produced to below 30 cycles.

I hope that you can use this authentic data. It seems to me rather to be

regretted that such a large mass of the published material is derived from hearsay instead of from authentic sources. This is not by way of criticizing Mr. Augspurger, whom I admire, nor his papers which have been more factual than most, but I feel these things should be checked before rather than after publication. For this, I'd be inclined to pin the responsibility on the publisher. You undoubtedly realize how many people feel a printed item is true, just because it is printed. This really puts a terrific moral responsibility on the publisher to try and keep his articles factual.

Hope, Ark. PAUL W. KLIPSCH

(The publishers of this magazine — and of most other responsible technical magazines, we hope — make every effort to be certain that the articles printed are correct and factual. In some fields, however, the authorities themselves differ as to what constitutes the facts, and nowhere is this so true as in the field of loudspeakers and their associated equipment. We could find authorities to check our articles, of course, but who could we find to check the authorities? — *Editor*)

WANTS CARTOONS

Dear Editor:

I am beginning to miss the cartoons in your magazine. Once upon a time you had anywhere from 5 to 10 cartoons in my favorite magazine. Now I can hardly find them. Not only that, but they seem to be shrinking in size, too. How come?

St. Louis, Mo. FRANK ALLROY

. . . ELIMINATED

Dear Editor:

I have noted your cartoons for some years now and to me they are getting worse all the time. Maybe there is something wrong with my sense of humor, but I wish you would cut them out and give us live reading matter instead. How about it?

Chicago, Illinois HAROLD DICKENS

(More cartoons? No cartoons? What do our readers want? Drop us a postcard with your vote.—*Editor*)

HIGH PERVEANCE?

Dear Editor:

In the February, 1957, issue (page 119), under the heading of 25CD6-GB I note you use the term high-perveance. I have checked and can find no definition of perveance. I would appreciate it, if you would enlighten me as to the meaning of this word.

Niles, Ohio JACK RICHARDS

The term "perveance" is an attempt to get a factor somewhat resembling that of straight dc ohmic resistance. (Plate resistance, as you know, refers to ac resistance as measured by small voltage changes near the operating point.) Thus, the perveance of a tube is a function (in a diode, where the term was first used) of the area of the

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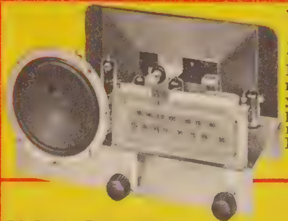
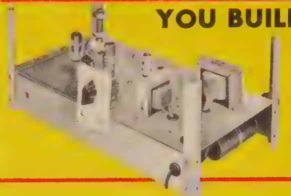


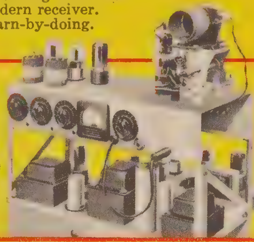
YOU BUILD AC-DC Superhet Receiver

NRI Servicing Course includes all needed parts. By introducing defects you get actual servicing experience practicing with this modern receiver. Learn-by-doing.



YOU BUILD Signal Generator

You build this Signal Generator. Learn how to compensate high frequency amplifiers, practice aligning typical I.F. amplifiers in receiver circuits. Make tests, conduct experiments.



YOU BUILD Broadcasting Transmitter

As part of NRI Communications Course you build this low power Transmitter, learn commercial broadcasting operators' methods, procedures. Train for your FCC Commercial Operator's License.

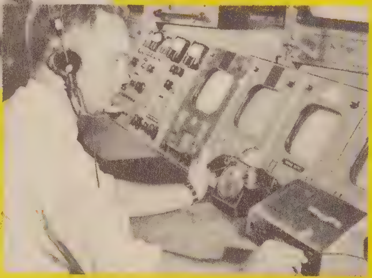
YOU BUILD Vacuum Tube Voltmeter

Use it to earn extra cash fixing neighbors' sets; bring to life theory you learn from NRI's easy-to-understand texts.

For Higher Pay, Better Jobs Be a Television-Radio Technician

Servicing Needs More Trained Men

Portable TV, Hi-Fi, Transistor Radios, Color TV are making new demands for trained Technicians. Good opportunities for spare time earnings or a business of your own.



Broadcasting Offers Satisfying Careers

4000 TV and Radio stations offer interesting positions. Govt. Radio, Aviation, Police, Two-Way Communications are growing fields. Trained Radio-TV Operators have a bright future.

J. E. Smith, Founder

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NRI is America's oldest and largest home study Television-Radio school. The more than 40 years' experience training men for success, the outstanding record and reputation of this school—benefits you in many ways. NRI methods are tested, proven. Successful graduates are everywhere, from coast to coast, in small towns and big cities. You train in your own home, keep your present job while learning. Many successful NRI men did not finish high school. Let us send you an actual lesson, judge for yourself how easy it is to learn.

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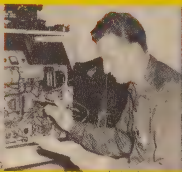
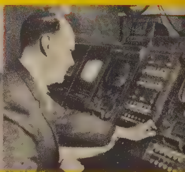
You don't have to know anything about electricity or Radio to understand and succeed with NRI Courses. Clearly written, well-illustrated NRI lessons teach TV-Radio-Electronic principles. You get NRI kits for actual experience. All equipment is yours to keep. You learn-by-doing. Mailing the postage-free card may be one of the most important acts of your life. Do it now. Reasonable tuition. Low monthly payments available. Address: **NATIONAL RADIO INSTITUTE, Washington 16, D. C.**

NRI Graduates Do Important Work

Now Quality Control Chief "Had no other training in Radio before enrolling, obtained job working on TV amplifiers before finishing course. Now Quality Control Chief." T. R. FAVALORO, Norwich, N. Y.



NRI Course Easy to Understand "I opened my own shop before receiving my diploma. I have had to hire extra help. I am independent in my own business." D. P. CRESSEY, Stockton, Cal.



Works on Color-TV "NRI changed my whole life. If I had not taken the course, probably would still be a fireman, struggling along. Now Control Supervisor at WRCA - TV." J. F. MELINE, NewYork, N Y.

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CORRESPONDENCE *(Continued)*

cathode and the distance between it and the anode. In a triode tube, the grid enters the picture and the perveance is a function of the product of the grid – and cathode – plate spacing and the cathode – plate spacing, as well as of the element areas. With other factors constant, perveance increases with cathode area and with less spacing between cathode and the first element outside the cathode.

A standard formula for perveance for a tube is:

$$G = \frac{i_k}{e_b^{3/2}}$$

where i_k is the cathode current and $e_b^{3/2}$ is the 3/2 power of the plate voltage.

(The current in a tube tends to rise not linearly with the voltage but in proportion to the 3/2 power of the voltage.) That is the reason for the peculiar expression.—*Editor*

AGAINST LICENSING AND PAY TV

Dear Editor:

I agree with Mr. Henry ("Licensing Not the Answer," page 21, September issue). Licensing will just mean an extra expense for the technician. I am a part-time technician myself and do not believe this business needs a licensed technician. I suggest that all who oppose licensing write and let no such move go through. Licensed technicians can pull underhanded deals too. If no complaint is lodged, they get away with it too.

I am also opposed to pay television. The enjoyment of television is the convenience of having the program brought into your own livingroom, *without cost.* If I have to pay to see a movie, I might as well go to the theater. The airways are free. What's wrong with the present method of sponsoring programs? I say those who oppose pay TV better speak up now and not permit any such move to go through. BRIAN CHIN KING
New York, N. Y.

RED AND FUZZBALL

Dear Editor:

I wish to report that I thoroughly enjoyed the article "Practical Color TV Installation" by Bob Middleton. I am looking forward to Part II. Part I was clear and very well received. Give us more. D. WADE PITTMAN
Fountain Head, Tenn.

Dear Editor:

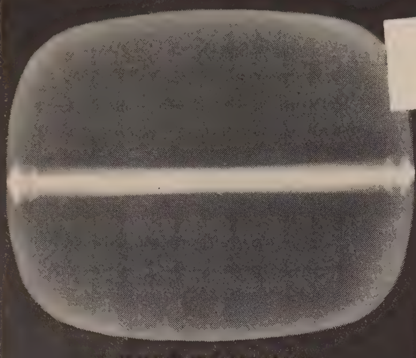
You can bet our boots I enjoyed the article titled "Practical Color TV Installation."

Sure would like to see more written like that. The fact that Bob Middleton tells *where* the adjustments are and what they look like helps me a lot. I mean the things around the picture tube (color), beam positioning magnets, etc. PETE KOWALCHIK
Kingston, Penn.

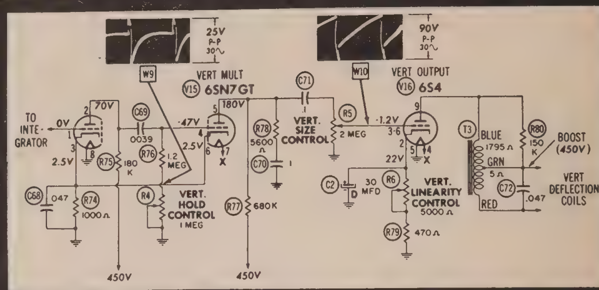
(And more in the same vein. No opposing votes yet.—*Editor.)* END

how long would it take you to solve this service problem?

SYMPTOM:
Loss of Vertical Sweep



(Based on an actual case history taken from the Howard W. Sams book "TV Servicing Guide")



PHOTOFACT helps you lick problems like this in just minutes for only* 2½¢ per model!

Let's take a look at this problem: This trouble symptom is present when there is no driving signal to the vertical deflection coils and when the horizontal scanning is normal. Look for the following possible causes:

1. Defective multivibrator or output tubes
2. Open coupling capacitors C71 or C69
3. Open linearity control R6 or cathode resistor R79
4. Open size control R5
5. Open output transformer T3

With the applicable PHOTOFACT Folder at your finger-tips, you trouble-shoot and solve this problem in just minutes. Here's how:

Using the Tube Placement chart (you'll find it in every PHOTOFACT TV Folder) you can quickly locate and check the multivibrator and output tubes.

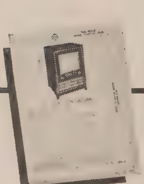
Tubes okay?—then: Check waveform at grid of vertical output tube (W10). Wave shapes and peak-to-peak values appear right on the PHOTOFACT Standard Notation schematic. Waveform correct?—then: Check for open R6, or R79 or for faulty components in the output plate circuit. The DC resistance of the vertical output transformer and the lead colors are also shown right on the schematic.

Waveform incorrect?—then: Check voltages at the pins of the multivibrator tube. They're right on the exclusive Standard Notation schematic.

Whatever the trouble, you'll locate it faster and easier with a PHOTOFACT Folder by your side. Be sure to use the complete Replacement Parts List to select the proper replacement for the repair.

Use the servicing method you prefer—checking of waveform, voltage or resistance—you'll find all the information you need at your finger-tips in PHOTOFACT. For only *2½¢ per model, PHOTOFACT helps you solve your service problems in just minutes—helps you service more sets and earn more daily!

*Based on the average number of models covered in a single set of PHOTOFACT Folders.



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Got a tough repair? Try this—at Howard W. Sams' own risk: see your Parts Distributor and buy the proper PHOTOFACT Folder Set covering the receiver. Then use it on the actual repair. If PHOTOFACT doesn't save you time, doesn't make the job easier and more profitable for you, Howard W. Sams wants you to return the complete Folder Set direct to him and he'll refund your purchase price promptly. GET THE PROOF FOR YOURSELF—TRY PHOTOFACT NOW!

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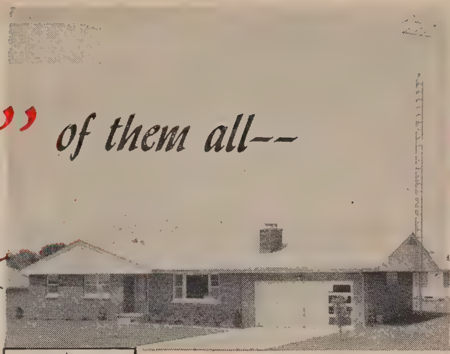

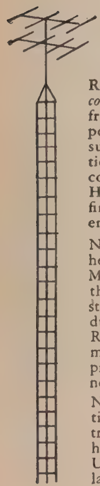

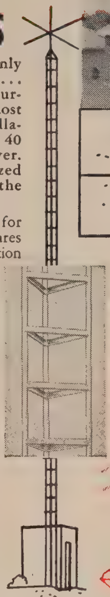

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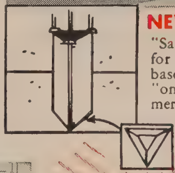
Rohn Towers are the only *complete line* of towers . . . from the No. 6 "all purpose" tower which is most suitable for TV installations, to the giant No. 40 communications tower. Hot-dipped galvanized finish is featured in the entire line.

No. 6 Tower is ideal for heights 50-120'. Features Magic Triangle construction that assures great strength, stability and durability. Stocking Rohn No. 6 Towers means you can fulfill practically all tower needs!

No. 40 Communications Tower for extreme heights and heavy duty work. Uses large 18" equilateral triangular design which allows heights up to 300 ft. or lesser heights where considerable strength is needed. Used widely for radio communication and micro wave throughout U. S. Sell this tower for these requirements existing in your locality.

Both the No. 6 and No. 40 Towers are in 10" sections and are easily installed without special equipment.

Also available: No. 30 Towers and a unique space-saver PACKAGED TOWER, the latter available in heights from 24' to 64'.



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"Same day" installation base available NOW for No. 6 and P. T. Tower! Use this unique base that permits "on the spot" erection and "on the ground" assembly. Towers are then merely "walked up" into position.

Telescoping MASTS

Heavy-duty hot-dipped galvanized steel tubing and rigid joints give extraordinary strength. Quick installation . . . mast attached to base—antenna fixed, then mast hoisted quickly to desired height. Utilizes special clamp and guy ring arrangement. Flanged interior section; crimped exterior section gives you a mast that won't pull apart with unequalled stability. Complete with guy rings and necessary erection parts. In 20, 30, 40 and 50 ft. sizes. Bases and ground mounts available.

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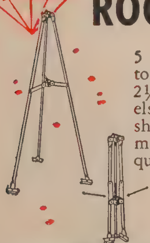
ROOF TOWERS



5 "Superior Design" roof towers in heights from 2½' to 10'. Most all models are collapsible for easy shipping and storage. All models ideal answer for quick, inexpensive roof top installation. Get full information on this fine line of roof towers.

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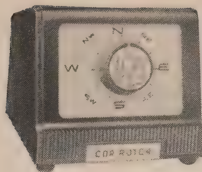

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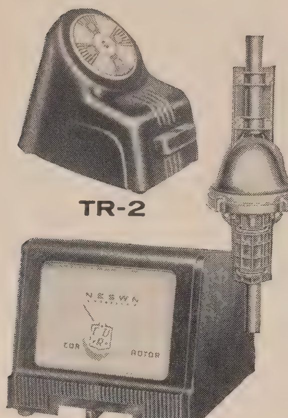

TR-2

TR-4

5-star feature . . .

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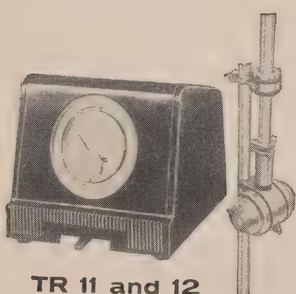
the growth of color TV means an even greater demand for CDR Rotors for pin-point accuracy of antenna direction.

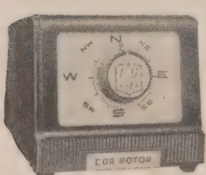
2 a better picture on more stations

CDR Rotors add to the pleasure of TV viewing because they line up the antenna perfectly with the transmitted TV signal giving a BETTER picture . . . and making it possible to bring in MORE stations.

CDR ROTORS



TR 11 and 12



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4 pre-sold to your customers

the greatest coverage and concentration of full minute spot announcements on leading TV stations is working for YOU . . . pre-selling your customers.

5 the complete line

a model for every need . . . for every application. CDR Rotors make it possible for you to give your customer exactly what is needed . . . the right CDR Rotor for the right job.

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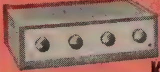

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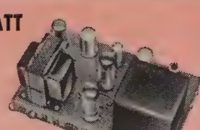
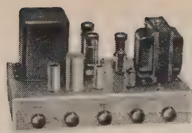
Compact, beautifully packaged & styled. Provides complete "front-end" facilities and true high fidelity performance. Direct tape head & magnetic phono inputs with NARTB (tape) & RIAA (phono) feedback equalizations. 6-tube circuit, dual triode for variable turnover bass & treble feedback-type tone controls. **Output Power:** 12 w cont., 25 w pk. **IM Dist.** (60 & 6000 cps @ 4:1): 1.5% @ 12 w; 0.55% @ 6 w; 0.3% @ 4 w. **Freq. Resp.:** 1 w: ±0.5 db 12 cps – 50 kc; 12 w: ±0.5 db 25 cps – 20 kc. **Harmonic Dist: 20 cps:** 2% @ 4.2 w; ½% @ 2.5 w; **30 cps:** 2% @ 11 w; ½% @ 6.3 w; **40 cps:** 1% @ 12 w; ½% @ 9.3 w; **2000 cps:** ½% @ 12 w; **10 kc:** 1% @ 10 w; ½% @ 6 w. **Transient Resp:** excellent square wave reproduction (4 usec rise-time); negligible ringing, rapid settling on 10 kc square wave. **Inverse Feedback:** 20 db. **Stability Margin:** 12 db. **Damping Factor:** above 8, 20 cps – 15 kc. **Speaker Connections:** 4, 8, 16 ohms. **Tone Control Range:** @ 10 kc, ±13 db; @ 50 cps, ±16 db. **Tubes:** 2-ECC83/12AX7, 1-ECC82/12AU7, 2-EL84, 1-EZ81. Size: HWD: 3⅝" x 12" x 8¼". 13 lbs. Mounts in or out of cabinet.

NEW! 50-WATT Ultra-Linear HIGH FIDELITY POWER AMPLIFIER



HF50 KIT $57.95 WIRED $87.95

Like the HF60 shown below, the HF50 features **virtually absolute stability, flawless transient response** under either resistive or reactive (speaker) load, & **no bounce or flutter** under pulsed conditions. **Extremely high quality output transformer** with extensively interleaved windings, 4, 8, & 16 ohm speaker connections, grain-oriented steel, & fully potted in seamless steel case. Otherwise identical to HF60. **Output Power:** 50 w cont., 100 w pk. **IM Distortion** (60 & 6000 cps @ 4:1): below 1% at 50 w; 0.5% @ 45 w. **Harmonic Dist.:** below 0.5% between 20 cps & 20 kc within 1 db of rated power. **Freq. Resp.** at 1 w: ±0.5 db 6 cps – 60 kc; ±0.1 db 15 cps – 30 kc at any level from 1 mw to rated power; no peaking or raggedness outside audio range. **All other specs identical to HF60 below.** Matching cover **Model E-2, $4.50.**



NEW! 50-WATT Ultra-Linear HIGH-FIDELITY INTEGRATED POWER AMPLIFIER HF52 with Preamplifier, Equalizer & Control Section

KIT $69.95 WIRED $109.95

Combines a power amplifier section **essentially identical** to the **HF50 power amplifier** with a **preamp-equalizer control section similar to HF20 below.** Provision for use with electronic crossover network & additional amplifier(s). See HF50 for response & distortion specs; HF60 for square wave response, rise-time, inverse feedback, stability margin, damping factor, speaker connections; HF20 for preamplifier, equalizer & control section description. Hum & noise 60 db below rated output on magnetic phono input (8 mv input for rated output), & 75 db below rated output on high level inputs (0.6 v input for rated output). Matching cover **Model E-1, $4.50.**

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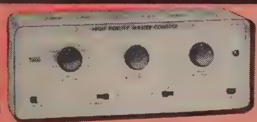


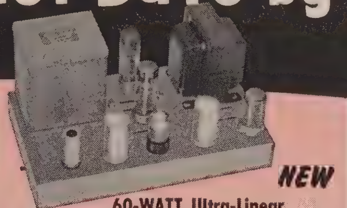
NEW

HIGH FIDELITY PREAMPLIFIER

#HF61A KIT $24.95, WIRED $37.95

With Power Supply: #HF61 KIT $29.95, WIRED $44.95

Will not add distortion or detract from the wide-band or transient response of the finest power amplifiers at any control settings. High quality feedback circuitry throughout plus the most complete control & switching facilities. Heavy-gauge solid brushed brass panel, concentric controls, one-piece brown enamel steel cabinet for lasting attractive appearance. **Feedback-type, sharp cut-off (12 db/octave) scratch & rumble filters. Low-distortion feedback equalization:** 5 most common recording curves for LPs & 78s including RIAA. **Low-distortion feedback tone controls:** provide large boost or cut in bass or treble with mid-freqs & volume unaffected. **Centralab printed-circuit Senior "Compentrol" loudness control with concentric level control. 4 hi-level switched inputs** (tuner, tv, tape, aux.) & **3 low-level inputs** (separate **front panel low-level input selector** permits concurrent use of changer & turntable). **Proper pick-up loading & atenuation** provided for all quality cartridges. **Hum bal. control.** DC superimposed on filament supply. 4 convenience outlets. **Extremely flat wideband freq. resp.:** ±1 db 8-100,000 cps; ±0.3 db 12-50,000 cps. **Extremely sensitive. Negligible** hum, noise, harmonic or IM distortion. Size: 4-7/8" x 12-5/16" x 4-7/8". 8 lbs.



NEW

60-WATT Ultra-Linear HIGH FIDELITY POWER AMPLIFIER #HF60 with ACRO TO-330 OUTPUT TRANSFORMER

KIT $72.95 WIRED $99.95

Superlative performance, obtained through finest components & circuitry. EF86 low-noise voltage amplifier direct-coupled to 6SN7GTB cathode coupled phase inverter driving a pair of Ultra-Linear connected push-pull EL34 output tubes operated with fixed bias. **Rated power output:** 60 w (130 w peak). **IM Distortion** (60 & 6000 cps at 4:1): less than 1% at 60 w; less than 0.5% at 50 w. **Harmonic Distortion:** less than 0.5% at any freq. between 20 cps & 20 kc within 1 db of 60 w. **Sinusoidal Freq. Resp.:** at 1 w: 35 kc at any level from 1 mw to rated power; no peaking or raggedness outside audio range. **Square Wave Resp.:** excellent from 20 cps to 25 kc, 3 usec rise-time. **Sensitivity:** 0.55 v for 60 w. **Damping Factor:** 17. **Inverse Feedback:** 21 db. **Stability Margin:** 16 db. **Hum:** 90 db below rated output. **ACRO TO-330 Output Transformer** (fully potted). **Speaker Taps:** 4, 8, 16 ohms. **GZ34 extra-rugged rectifier** (indirectly-heated cathode eliminates high starting voltage on electrolytics & delays B+ until amplifier tubes warm up). **Input level control.** Panel mount fuse holder. Both **bias** and **DC — balance** adjustments. Std octal socket provided for pre-amplifier power take-off. Size: 7" x 14" x 8". 30 lbs. Matching cover **Model E-2 $4.50.**

NEW

COMPLETE with Preamplifier, Equalizer & Control Section 20-WATT Ultra-Linear Williamson-Type HIGH FIDELITY AMPLIFIER #HF-20

KIT $49.95 WIRED $79.95

A low-cost, complete-facility amplifier of the highest quality that sets a new standard of performance at the price, kit or wired. **Rated Power Output:** 20 w (34 w peak). **IM Distortion (60 & 6000 cps/4:1) at rated power:** 1.3%. **Max. Harmonic Distortion between 20 & 20,000 cps at 1 db under rated power:** approx. 1%. **Mid-band Harmonic Distortion at rated power:** 0.3%. **Power Response (20 w):** ±0.5 db 20-20,000 cps; ±1.5 db 10-40,000 cps. **Freq. Resp.** (¼ w): ±0.5 db 13-35,000 cps; ±1.5 db 7-50,000 cps. **5 feedback equalizations** for LPs & 78s. **Low-distortion feedback tone controls:** large boosts or cuts in bass or treble with mid-freqs. & volume unaffected. Loudness control & separate level set control on front panel. Low Z output to tape recorder. **4 hi-level switched inputs:** tuner, tv, tape, aux; **2 low-level inputs** for proper loading with **all** cartridges. **Hum bal. control.** DC superimposed on filament supply. **Extremely fine** output transformer: interleaved windings, tight coupling, careful balancing, grain-oriented steel. 8½" x 15" x 10". 24 lbs. Matching cover **Model E-1, $4.50**

NEW COMPLETE with FACTORY-BUILT CABINET— 2-WAY HI-FI SPEAKER SYSTEM #HFS1 $39.95

Genuine 2-way book-shelf size speaker system. **Jensen** heavy duty 8" woofer (6.8 oz. magnet) & matching **Jensen** compression-driver exponential horn tweeter with level control. Smooth clean bass & crisp extended highs free of coloration or artificial brilliance. **Factory-built** tuned bass reflex birch hardwood cabinet (**not** a kit) constructed to high quality standards. Neutral acoustical grille cloth framed by a smooth-sanded solid birch molding. **Freq. Resp.** measured 2 ft. away on principal axis in anechoic chamber with 1 watt input – **Woofer:** ±4 db 80-1800 cps; **Tweeter:** ±2 db 2800-10,000 cps; **Crossover Region:** 1800-2800 cps, shift in level over this region depends on tweeter level control setting. Power-handling capacity: 25 watts. Size: 23"x11"x9". 25 lbs. **Wiring Time:** 15 min.

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TACTILE ELECTRONICS

. . . The Sense of Touch Can Be Conveyed From Afar . . .

THE direct extension of the first human sense—hearing—over appreciable distances began with the telephone in 1876. In 1926, John Logie Baird of London, England, added the second sense—sight—when television made its debut.*

Remote perception of the third sense—touch—by *teletactility*—feeling at a distance—has been partly with us for some time. It is possible that Elisha Gray was the first to approach it with his *telautograph* (1888), which is still in use today. By means of the telautograph you can write at a distance, instantaneously, in your own handwriting. True, this is not transmitting actual touch at a distance, but it comes close to it. Some of the telautograph features may be used in future teletactile apparatus.

To understand better the problem of teletactility and its enormous future technical applications, we should first analyze its essentials. The tactile sense of touch or feeling means coming in contact with something—a sensation conveyed through the tactile nerves. These sensitive nerves are highly susceptible to pressure, variations of surface from polished to rough unevenness such as velvety, sticky, soft or hard, etc. In addition, the tactile nerves are sensitive to temperature.

While no single instrument—let us call it a *Teletac*—yet in existence can successfully feel at a distance, there is no reason in the world why it cannot be developed in the future. We have practically all the means at hand to bring it to life soon.

Indeed, for many years industry has had (and used) parts of the future Teletac. Let us cite a few. In paper manufacturing, electronic instruments continuously feel and check the thickness, smoothness (coating) of the paper in process of manufacture. The instruments alert the attendants if the paper runs uneven, or stop the machine automatically. For thin (tissue) papers, electronic contacting devices guard against small holes in the sheet. Similar instruments are used in the manufacture of rolled metal sheeting, such as nickel, copper, brass, tinfoils, etc. Devices of the same kind are used in the textile industry to control weaving machinery for smoothness in finishes, density, thickness (weight), etc., of the final cloth product.

In the printing industry, where high-speed presses require extra-fast output, the metal rollers are heated or other heating means are used to dry the inks rapidly on the running paper sheet as it issues from the press. Thermo-electronic devices maintain an exact optimum temperature while the press runs.

In rubber manufacture, special electronically rigged rollers check the correct softness or hardness of rubber stock. Here, too, the electronic sensing device stops the machinery if the end product is too hard or too soft.

A recent sensing device, called the *proximity limit switch*, uses a special transducer. The entire instrument, less than 2 x 6 inches, is actuated, by the presence of magnetic materials, over a wide range of shapes, sizes, weights, roughness, whether at rest or speeding. The sensing head requires no physical contact and is effective up to a 1-inch distance. It has no moving parts and has many industrial uses.

The *Physiophone* of the author, first demonstrated in 1920 at the New York Institute for the Deaf, transformed sound waves into high-frequency electric waves. These were then conveyed via hand electrodes to the deaf. The sound was felt as pleasant, slight tingling shocks. By holding hands a group of totally deaf persons could simultaneously "hear" music, speeches, etc.

Of interest also was a later electric instrument called *teletactor* used by the deaf. It converts sound waves into vibrations which are detected by the finger tips.

But let us now consider the comprehensive Teletac, a future instrument with which you can actually feel at a distance. The complex transmitter—not necessarily large—could then be plugged into any telephone which by that time will also be color-television equipped. You could then see, feel and order a suit or a bolt of cloth or any other merchandise across the continent. Fantastic? Yes, but not impossible. The sales clerk upon request would run his Teletac over the goods and you could actually feel the texture at a distance. Your Teletac receiver, an integral part of your own phone, requires that you merely insert your finger into its opening. Instantly you will feel the fabric and you will distinguish between silk, velvet, wool or linen. A doctor, too, can in this manner feel a patient's pulse, take his temperature, etc.

How can this be done? At the transmitter we have a metallic sensing "brush." Its smooth, round "bristles" are of metal. The short bristles, very close together, are mounted on a sort of telephone diaphragm with an electromagnet under the diaphragm making the device act similarly to a telephone. Moving the bristles over a rough texture vibrates the diaphragm more than a smooth surface. By amplification the receiver diaphragm is displaced exactly as the one at the transmitter. The receiver has a similar diaphragm with bristles on which your finger rests. You now have the illusion of feeling the exact consistency of the texture at the far transmitter. Your finger is at rest, but *the bristles have the motion,* acting as if you moved the finger over the distant material—which is what actually occurs. This is of course only one way to accomplish teletactility. There are many other and more refined ways.

At the transmitter a thermistor surrounds the bristles at the same level as their tops but does not touch the bristles. When the ring touches any material—or the human body, for instance—the thermistor transmits an electric impulse over the line. At the receiver this impulse—amplified—heats a similarly shaped heater rim. Hence your finger senses the same degree of heat as that existing at the transmitter. A doctor can thus place a thermometer in the Teletac receiver and read the patient's temperature, provided the patient had a Teletac transmitter.

This is only a *very* sketchy and incomplete description of such a device without future refinements. For the immediate future and for industrial purposes, the problem is much simpler.

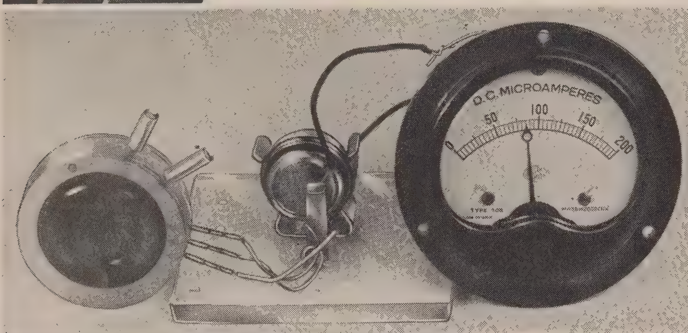
For oil-well drilling, for instance, the sensing organ can be quite rugged to tell the men instantly in what type of strata the drill head is biting. Pyrometers for heat interpretation at a distance are already on the market.

One interesting, noncommercial Teletac could easily be adapted for the blind. Braille books, using elevated dots for tactile reading are expensive. In the future, one monitoring person could guide a transmitter over the pages of a single book. Innumerable blind individuals could then simultaneously feel–read such a braille broadcast at small cost.

Industry has thousands of uses for various electronic teletacs. Few will be alike, as every manufacturing plant has its own special conditions. Yet one thing is certain: electronics will be able to supply *any* type of Teletac required to feel and sense efficiently at a distance. —*H.G.*

* Paul Nipkow in Berlin was first with the invention of the scanning disk, in 1884, but no fast, light-sensitive photoelectric cells were then in existence. Hence he never achieved true television.

Two new approaches to AMPLIFICATION



New semiconductor and electrolytic devices may push ultra-high-frequency limits upward; far outdo transistors in circuitry simplification and compactness

By ERIC LESLIE

(Top) Spacistor Collector vertical rod at bottom right; base, rod slanting to bottom left; injector, left slanting catwhisker; modulator, one at right.

(Bottom) Solion (left) with special 0.9-volt battery (center) and an indicating meter, as used to measure moderate sound pressures.

WITHIN the past few months two new amplifying devices have appeared in the field where for so many years de Forest's electron tube ruled alone, moving aside a little only in the past decade to permit the transistor to do some of its jobs.

One of the new devices, Raytheon's Spacistor (RADIO-ELECTRONICS, September, 1957, page 8) looks like a member of the transistor family. The other, the Naval Ordnance Laboratory's Solion (rhymes with Napoleon) ("Electrochemical Units," RADIO-ELECTRONICS, August, 1957, page 12), is like nothing else in this world. A flat cylindrical cell, which may be less than 2 inches across, divided or partly divided into two sections and filled with an electrolyte, it is a closer relative to the old wet cells that used to operate doorbells than to anything now used in the electric–electronic field. Yet it can measure pressures, flows, accelerations, and performs other functions which would otherwise require expensive, complex and bulky equipment. Operating on just under 1 volt, it runs for such long periods of time on an electric cell (battery XA-10B) specially constructed for it as to make even the transistor look like a current hog.

Neither of these devices has reached the commercial market, and it is still too early to predict what part they will play in an electronic world where the tube and transistor have already proved themselves practical and versatile amplifiers. The Spacistor is expected to find its most useful applications in the uhf field; the Solion is limited to a top of 400 cycles at present, but can operate from there down to dc. It can also be used as a transducer to turn electric into mechanical energy.

The very name of the Spacistor puts it in the solid-state amplifier family, whose best known member is the transistor. But this semiconductor device acts in many ways more like a vacuum tube than a transistor. (See Fig. 1.)

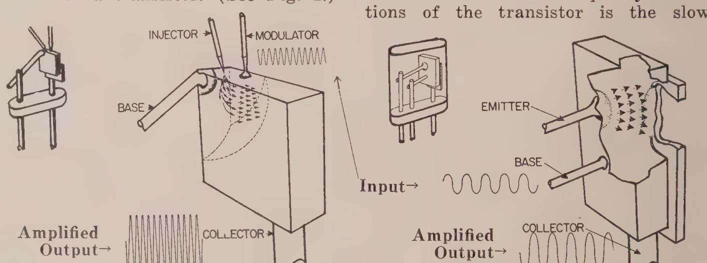


Fig. 1—Two amplifiers compared. *Spacistor*—High voltage is applied between collector and base in direction to produce strong electric field and practically no current. Electrons injected into this field flow very rapidly to collector. Flow is modulated by signal applied between base and modulator, which acts like vacuum-tube grid. *Transistor*—Similar but lower voltage is applied between collector and base. Since emitter (in n-p-n transistor) is more negative than base area near it, it injects electrons, which flow to positive collector (at lower speed than in the Spacistor, because of lower collector voltage). Signal to be amplified is applied between base and emitter, current from which increases and decreases as it becomes more or less negative with respect to base. Action is same in p-n-p transistor, with reversal of voltages and current flow.

The Spacistor operates at 100 volts; transistors are commonly low-voltage devices. Transistor output and input impedances are low; those of the Spacistor are high, even higher than for vacuum tubes. Transistor input capacitances, conversely, are high; the Spacistor's lower than those of vacuum tubes.

The transistor's most serious limitation has been frequency. Readers remember when commonly available ones would work well over only a little more than the audio range. The frequency limit has been pushed steadily upward since that time, but is still well below that of vacuum tubes.

One reason for the frequency limitations of the transistor is the slow

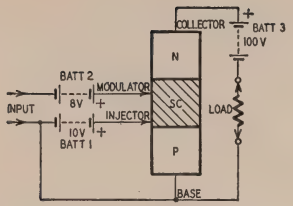


Fig. 2—Idealized cross section of an experimental Spacistor.

diffusion of charge carriers (electrons or holes) through the base region. The applied voltages are usually low, and little push is applied to the charge carriers. Therefore, they move at a relatively low speed and when faced with rapid alternations of signal current just can't get to their destinations rapidly enough to produce an output exactly mirroring that of the input. In the language of the scientists, the electric field in which they move doesn't give them enough acceleration.

A vacuum tube—with a drop of usually more than 100 volts between cathode and plate—has a strong field, and electrons are hurried right along in it. The same is true of the Spacistor, where 100 volts is applied across the body of the semiconductor, between collector and base in Fig. 2.

The unit is a p-n junction hooked up in reverse bias (the direction that opposes current flow). Thus, there is a sharp potential gradient throughout the Spacistor, and we find a heavy space charge somewhat like that in a vacuum tube. This charge exists to some extent throughout the semiconductor, but is much heavier in the area marked SC. In this area particularly, moving charges are speeded by high voltage across the Spacistor body.

So the problem of speeding up the charge carriers is solved. All that remains now is to get some charge carriers to speed up. We also have to control our stream of charges so as to get amplifier action. The tungsten-wire contact marked INJECTOR supplies the charges. It is connected to the base through a battery (BATT 1) which biases it slightly more negative than that part of the base with which it is in contact. Therefore it emits electrons into SC, the space charge area. The flow of electrons from the injector is limited by the backward pressure of the space charge, as in a vacuum tube.

The MODULATOR is placed a little farther along the body of the Spacistor and is also biased (with BATT 2) to be somewhat more negative than the area under it. But it is doped with a little p-type material, and thus forms a p-n junction with the underlying semiconductor. Since its bias is negative, it can emit no holes into the base and therefore draws no current.

The input signal is applied between the modulator and the base. The modulator acts like the grid of a vacuum tube; changes of voltage on it vary the current from the injector. The dc bias voltage on the modulator also makes it act something like the screen grid in a vacuum tube. The field due to this voltage is felt through the whole space-charge region and has a greater effect on the no-signal current from the injector than does the voltage from BATT 3, across the whole Spacistor. Thus it tends to prevent the injector current from being affected by changes in the voltage between base and collector. This keeps the output impedance reasonably high—in excess of 30 megohms for an injected current of 30 ma. (The input impedance is likewise high —also about 30 megohms.)

The Spacistor is still in the early experimental stages and has not yet been tested to the limits of its capabilities. No checks at very- or ultra-high frequencies have been run, and the full amplifying power of the device is still unknown. Low-frequency power gains of 70 db and voltage gains of 3,000 have already been obtained from experimental units. Transconductance of present Spacistors is considerably below that of good vacuum tubes, but is comparable to that of dry-cell types.

The Spacistor's output capacitance is extremely low—values of less than 1 $\mu\mu$f are entirely feasible—and it is expected that amplifiers can be built to operate at frequencies higher than 1,000 mc. Another advantage of the Spacistor is the isolation of input and output circuits by the modulator's screening action—a valuable feature in multistage circuits. It is further expected that it will be possible to construct Spacistors from much higher-temperature materials than transistors.

The ionization cell

Many of us were given some idea of ionic action in our student days. In practical life, the flow of electrons has so far overshadowed that of ions that we may have forgotten that ions can carry current as well as electrons. Yet the ion still does play its part in our everyday life. It does useful work in gas tubes, like mercury-vapor rectifiers, thyratrons and voltage regulators, and is even more common in electrolytic capacitors, where ions actually form one of the plates. A more conspicuous (but less useful!) form of ionic activity is corona discharge, ever more familiar with increasing voltages on TV tubes.

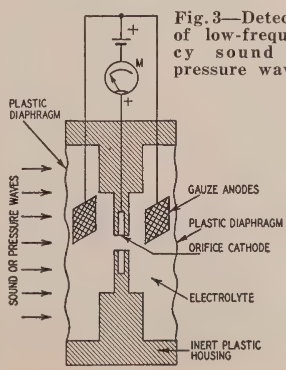


Fig. 3—Detector of low-frequency sound or pressure waves.

Ionization is the breaking down of atoms under electric stress. An atom so broken down may lose an electron, and be dissociated into a negative electron and a *positive ion.* Or it may gain an electron and become a *negative ion.*

An ion, then, is a charged particle of matter—an atom that has gained or lost one or more electrons.

Ions may be made by collision. In a mercury-vapor rectifier or thyratron, electrons on their way from cathode to anode knock electrons out of the gas atoms they run into on the way. These electrons accompany the first ones to the plate, increasing the tube's current output.

Ions may also be made chemically. *Electrolytes* are chemical solutions whose constituents may be ionized. A very common example of such ionization is the electric primary cell (a flashlight battery is the most common example). Chemical action dissolves zinc atoms out of the can. They leave in the form of positive ions, leaving electrons behind them, and unite with negative ions of chlorine to form zinc chloride. Energy is released by this chemical reaction; electrons piled up in the zinc electrode (the can) constitute a negative voltage and can be made to do work on their way back to the positive (carbon) electrode.

In some types of electrolytic cells we may put an external source of electricity across the electrodes instead of expecting energy from the cell itself. (The electrolytic capacitor again comes immediately to mind.) A cell with two electrodes of the same metal and an electrolyte composed of a salt of that metal can be used in electroplating. Atoms go into solution as positive ions at the positive electrode, each atom leaving an electron behind. These ions drift toward the negative electrode, where each one picks up its missing electron and again becomes an atom of the metal. (If the negative electrode is not of the same metal as the positive one, it will be *plated* with metal from it.)

The Solion

A third type of electrolytic cell—the one used in the Solion—is one in which the electrodes take no part in the action. A typical Solion has platinum electrodes and a mixture of iodine molecules and potassium iodide in solution. The potassium iodide breaks up into positive potassium and negative iodide ions. The iodine molecules, drifting to the negative electrode at a rate virtually independent of the low voltage which is applied to the Solion, acquire electrons and become negative iodide ions. These ions move to the positive electrode, give up their electrons, again become iodine molecules.

The quantity of electric current that will flow is controlled by the rate at which iodine molecules are broken down into iodide ions at the cathode

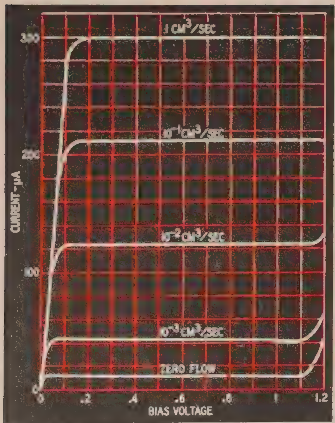


Fig. 4—Response of cell of Fig. 3 as signal is increased.

(negative electrode) rather than by their re-formation into iodine molecules at the positive electrode. Hence the current flow is independent of voltage and depends on factors such as stirring (movement of solution past the cathode).

Thus we can use mechanical energy (stirring) to regulate electrical energy or convert mechanical energy to electrical energy. The first application of such an effect that comes to mind is a flow meter, and the Solion can be used for that purpose.

Fig. 3 is an example of a flow meter. This is a typical Solion used as an acoustic detector (in other words, as a sort of microphone).

At the orifice cathode, iodine is changed to iodide ions. At the gauze anodes, iodide ions are reconverted to iodine molecules. The number of iodine molecules coming into contact with the orifice cathode controls the flow of electric current in the solution.

When there is a flow of electrolyte through the cathode orifice, the number of iodine molecules coming into contact with the cathode is greater than when the liquid is still. Sound waves striking the diaphragm at the left (Fig. 3) exert pressure on the liquid, causing it to flow back and forth through the orifice in proportion to the intensity of the sound. The meter indicates current changes accordingly.

The peculiar shape of the cathode is due to the response desired. A cathode so constructed will have roughly a logarithmic response, as indicated by Fig. 4. A cell of the type shown in Fig. 3 may pass a current of less than 20 μa with no flow of liquid through the cathode orifice. At .001 cubic centimeter (cc) per second the current increases to more than 40 μa, an easily measurable difference. At 1.0 cc per second, current is more than 300 μa.

The same type of cell may be used to indicate and measure low-frequency changes of pressure that would not be called sound waves. Results are particularly good between 2 and 10 cycles, though the cell can be designed to increase response at a desired frequency (resonate) and is useful up to a top limit of about 400 cycles with present designs.

The "separated detector"

The Solion principle may be used in a variety of modified designs for special jobs. An example of a slightly different type of Solion is that in Fig. 5. It is adapted to the measurement of unidirectional flows and pressures. The hookup resembles that of Fig. 3, except that one of the outside electrodes is at the same voltage as the cathode, which in this cell is a piece of closely woven platinum gauze. (Its response is linear rather than logarithmic.) The ions tend to drift toward the left (positive) electrode (anode) where they become iodine molecules. In time, practically all the iodine ions find themselves, under the attraction of the anode, on the left side of the cathode (separator electrode). Now, if there is a movement of liquid toward the right, due to pressure on the left diaphragm, new ions are brought into contact with the cathode, and increased current flow is indicated on the meter. If flow is from right to left, there is no action—there are practically no iodine ions in the liquid in the cell's right section.

The electro-osmotic cell

The Solion is a two-way transducer—it can act as a flow meter which converts mechanical energy to electrical energy, and as a pump which converts electrical energy to mechanical energy. This pump can be made without moving parts by using *electro-osmosis*.

An electro-osmotic pump is shown in Fig. 6. It has long been known that when a liquid of low conductivity is placed in a tube of—for instance—glass, the inside surface of the tube takes on an excess negative charge. The solution close to this surface has an excess positive charge, its atoms having lost electrons to the glass. The great majority of these positive ions are tightly bound to the surface and are not free to move. Further out, they are freer to move, though they are also less numerous.

If a voltage is applied to electrodes at the ends of the tubes, as shown in Fig. 6, these ions start to move to the left, taking other molecules with them.

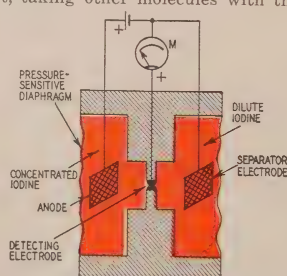


Fig. 5—Separated detector measures unidirectional liquid motion; acts as rectifier on back-and-forth flows.

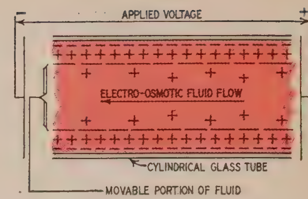


Fig. 6—How an electro-osmotic flow is produced.

The solution is literally "dragged by its skin" through the tube. The rate of flow can be varied by varying the voltage applied across the ends of the tube.

In the "pump" used in some Solion devices, the narrow tube is replaced by a porous disc which is essentially an arrangement of thousands of extremely small tubes. The electrodes are placed on the flat surfaces of the disc and thus liquid is forced from one side of it to the other.

An example of an electro-osmotic cell is shown in Fig. 7. It uses distilled water as a low-conductivity fluid, and the flow of liquid can be made linear with the applied voltage.

Such a cell may be combined with the separated detector of Fig. 5 to form an amplifier. A typical example is an electro-osmotic cell with 1 volt applied across it. The current can be held to about 30 μa, a power input of 30 microwatts. A linear separated detector hydraulically coupled to the electro-osmotic cell can be designed to give an output of 10 ma across 100 ohms. This is 10 milliwatts out for 30 microwatts in, a power gain of 330.

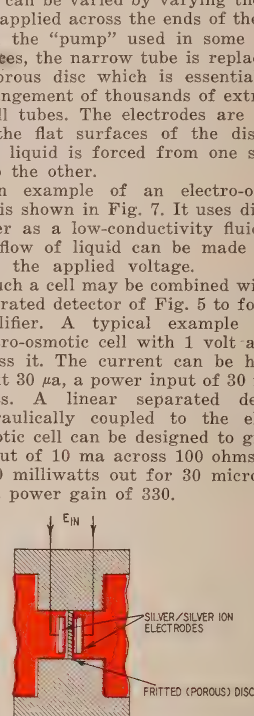


Fig. 7—Voltage applied to electro-osmotic cell produces liquid flow.

The possibilities of the Solion are by no means limited to the types described above. Other designs for special purposes or for obtaining outputs bearing a special mathematical relation to the input have been designed. But even those already described seem to have a wider range of applications than can at present be predicted or imagined. They are expected to be particularly useful in airplane instrumentation. Three of them coupled together, according to the Naval Ordnance Laboratory, can be used to show directional changes in the three dimensions through which an airplane flies, replacing hundreds of pounds of bulky equipment with three extremely simple, compact units whose weight is measured in ounces. The same compactness and simplicity are likely to open up many applications in industrial and other fields. END

...more about transistor types...

Part I—How drift and Unijunction transistors work and a discussion on the manufacture of alloy and diffusion transistors

By PAUL PENFIELD, JR.

IN October and November, 1956, I attempted to clarify some of the confusion which was inevitable as a result of the barrage of numerous types of transistors, many with very strange-sounding names. Within the past year some new transistor types have appeared, specifically RCA's Drift transistor and G-E's Unijunction. In addition, there has been some recent confusion about the effects of various manufacturing methods on transistor properties. Therefore, it seems appropriate to go over this question.

Drift transistors

The major limit on high-frequency response of junction transistors is the time it takes holes (for p-n-p transistors) to wander or diffuse across the base. Inside the base region there is no electric field, and the only reason why the holes travel across at all is that there are more of them near the emitter and they tend to spread out evenly.

There are three main ways to get around this effect. One is to make the base extremely thin (as in surface-barrier or micro-alloy transistors). Another is to devise a structure which does not have any current carriers diffusing, and restricts the flow of carriers directly instead (the field-effect transistor). A third way is to build an electric field in the base of an ordinary junction transistor to make the holes scoot across faster. When holes are acted on by an electric field they drift much faster than they would otherwise diffuse. The p-n-i-p transistor ("Confused About Transistor Types, Part I," RADIO-ELECTRONICS, October, 1956) has such a built-in electric field, but it is not as efficient as the one in the drift transistor.

The built-in electric field is produced by having a difference in the number of donor atoms distributed in various parts of the base. Near the emitter there are more than near the collector. The "why" is not obvious but, if properly done, this graded-impurity base

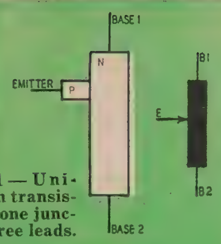


Fig. 1—Unijunction transistor has one junction, three leads.

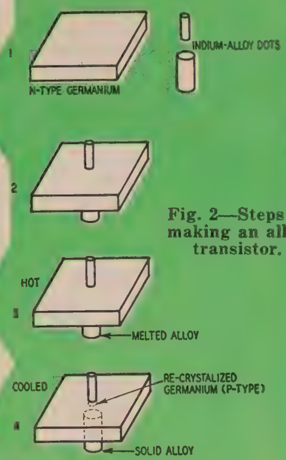


Fig. 2—Steps in making an alloy transistor.

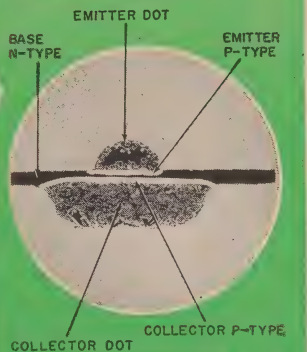


Fig. 3—Cross-section photograph of an alloy transistor. Note that the junctions are parallel. *(Photo courtesy Raytheon Mfg. Co.)*

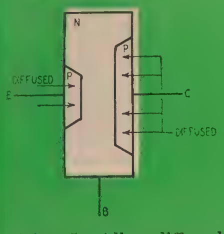


Fig. 4—Diffused E-C transistor. Special masks control the area of diffusion.

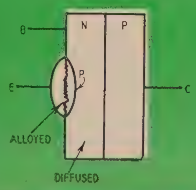


Fig. 5—Alloy-diffused transistor uses best features of alloy and diffused techniques to make a good drift transistor.

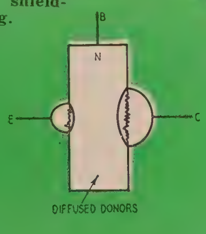


Fig. 6—Normal construction of drift transistor. Fourth lead is often added to provide shielding.

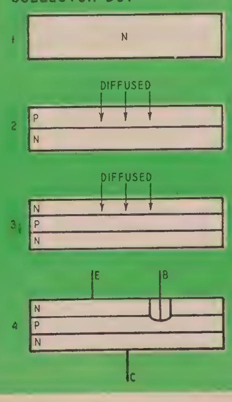


Fig. 7—Steps in making a double-diffused transistor.

produces an electric field which is in the proper direction to help holes cross rapidly to the collector.

The drift transistor is also called a diffused-base transistor because this describes the way the impurities are placed in the base. However, in operation, drift by electric field, not diffusion, is the method used for getting the holes across the base. Do not be confused by these terms.

This arrangement also leads to a small collector capacitance and a low base resistance—both desirable effects for high-frequency operation. Because of these factors the drift transistor can operate in the tens of megacycles.

The Unijunction

Formerly known as the double-base diode, this device (shown in Fig. 1) has only one junction but two base contacts. (See "Using the Unijunction" RADIO-ELECTRONICS, July, 1957.) If it had an additional collector region on the right, it would be just like a tetrode transistor.

In operation, a steady current is passed between the two base electrodes, and the point where the emitter is located is at some voltage above base 2. As the emitter contact's potential is raised, nothing much happens until it reaches the potential of the base region directly opposite it. At this point the junction at the emitter becomes forward biased, and the current flows in.

The interesting thing is that as soon as the emitter junction passes current, the effective base-to-base resistance drops considerably because of the holes which the emitter passes into the base. Once this happens, the point in the base near the emitter junction will drop in voltage, causing the emitter to be even more forward biased, causing more emitter current, etc. This is an unstable condition, and the current would run away if it were not limited by external resistors. The device is now in a low-voltage high-current condition and is effectively on whereas before it was off.

The Unijunction transistor is not useful as an amplifier, but is good for switching circuits, multivibrators, etc. It has been compared to the thyratron because its firing action is similar.

Transistor differences

Two transistors may be different, and therefore be given different names, for a number of reasons. They may be different types or they may be made from different materials—germanium, silicon or some other semiconductor.

Generally speaking, silicon is better at higher power levels and germanium at higher frequencies. In the future, one of the dozens of uninvestigated semi-conductors may turn out to be better transistor material than either germanium or silicon.

But an important third difference may be the method of manufacture. Junction transistors, for example, can be made many ways, and the transistor's characteristics depend on the method used.

In making transistors the idea is to make two p-n junctions close together. Remember that a p-region is formed wherever the acceptor density is greater than the number of donor impurities, and n-type material has more donors than acceptors. Methods of making transistors depend on schemes to move impurity atoms about and change their density.

Four such schemes are important. One is crystal-growing with controlled amounts of impurities. Another is melting a piece of germanium and letting it refreeze (recrystallize). The third is a diffusion operation conducted at moderately high temperatures, and last comes the very important alloy technique. Many manufacturing methods use more than one of these four techniques.

*Alloy transistors** are by far the most common, especially for everyday applications and for power transistors. Here we start off with, say, an n-type chip of germanium (see Fig. 2) and place small dots of indium-gallium-silver alloy on it. Upon heating, this alloy melts and dissolves some of the germanium. When the temperature is lowered, the germanium nearest the n-type germanium refreezes to form a single crystal, but heavily doped with gallium, which is an acceptor. Thus this region will be p-type.

In practice, two dots are placed on the chip of germanium simultaneously, one to be the collector and one the emitter. Fig. 3 is a microphotograph of a cross-section view of a completed structure. Special techniques were used to make the p-type regions, emitter and collector, appear white. Contact is made by soldering a wire onto the two dots and making an ohmic contact to the base region.

This method is simple and cheap and gives nearly 100% yield when done with care. Unfortunately it is not easy to control the base width accurately, so alloy transistors are not too good for high frequencies.

Silicon p-n-p and n-p-n alloy transistors are possible, as are germanium n-p-n models, but in each of these cases there are still unsolved problems.

Diffusion types

Impurity atoms such as donors and acceptors can diffuse through solid germanium at moderately high temperatures just as a drop of ink will slowly diffuse through a glass of still water. The rate at which they diffuse depends on the temperature and also on the material.

Diffusion can take place from plated electrodes made of the diffusing material or from a vapor of the material. If doped material is heated in a vacuum, impurities will diffuse *out* from the surfaces.

Diffusion is a very versatile technique for moving impurities to form junctions, although not enough information is yet available about it. The temperature applied is moderate so the germanium does not melt, and the time required is measured in minutes so the process can be controlled fairly accurately.

Often, diffusion will occur in making other types of transistors, and it is not really known what role diffusion has in making alloy transistors. Because it is not easy to tell which mechanism is at work, alloy transistors used to be called diffusion transistors.

A *diffused emitter–collector* (or *diffused E-C transistor*) is made by diffusing in acceptor impurities on two sides of a thin slab of n-type material (see Fig. 4) to form two junctions. The device looks much like an alloy transistor.

An additional step is required to make contact to the p-regions, raising the cost slightly, but an advantage is that for power transistors the heat sink can be attached much closer to the collector junction. This type of construction is best suited for silicon and germanium power transistors. Both p-n-p and n-p-n transistors can be made.

An *alloy-diffused* (or *diffused-base*) transistor is made by diffusing an n-type layer on the surface of a p-type crystal. This n-layer becomes the base (as shown in Fig. 5) and the original crystal the collector. A p-type emitter is alloyed in on the top surface.

This technique is rather easy with germanium and gives a donor distribution in the base which makes the completed unit a drift transistor, not a normal junction transistor.

Alternatively, the original material could be intrinsic or slightly n-type, and both the emitter and the collector could be alloyed after the diffusion process. Fig. 6 shows the construction, which is used in commercial drift transistors.

Double-diffused transistors, still not commercially available, are quite practical for silicon. Here two diffusions are used, in the order indicated in Fig. 7. First a p-layer is diffused as the base and then on top of this, at a lower temperature, an n-layer is diffused on as the emitter.

There are several undesirable features about the double-diffused transistor, such as the necessity to drill a hole through the emitter region to make connection to the base. However at present this technique is one of the most promising for high-frequency silicon transistors.

Next month we will continue with this discussion of manufacturing methods. Bonded, micro-alloy, grown-junction, rate-grown, grown–diffused and melt-back transistors will be covered.

TO BE CONTINUED

* Also known as alloy-junction, alloyed, fused-junction, fusion-alloy, diffused-alloyed, fused-alloy, and formerly known as diffused-junction, alloy-diffusion and diffused transistors. Do not be confused because of the many names, some of which are close to cr the same as names for different manufacturing methods.

Protect your transistors with circuit breakers

TRANSISTOR CIRCUIT BREAKERS

By A. H. TAYLOR

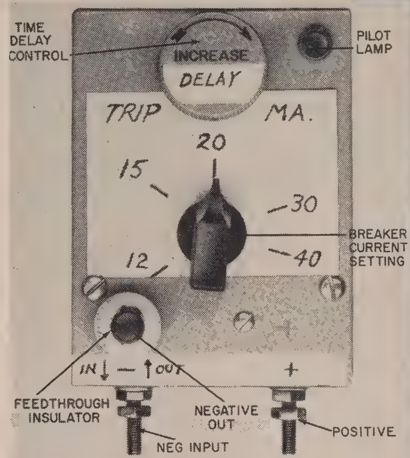
TRANSISTORS need protection against mistakes in any circuit, but especially in class-B amplifiers. Fuses are simplest but their cost tempts you to fuse too heavily and their resistance makes trouble in low-impedance circuits.

You can make a circuit breaker that has lower resistance than a fuse from a transistor and a relay. It will soon pay for itself. The principle is very simple and is also good for using cheap, high-resistance meters in circuits which will not tolerate their resistance. Place a low resistance (R1) in series with the load and apply the drop across it to the emitter and base of a transistor as in Fig. 1. Put the relay coil (or meter) in series between the collector and the battery.

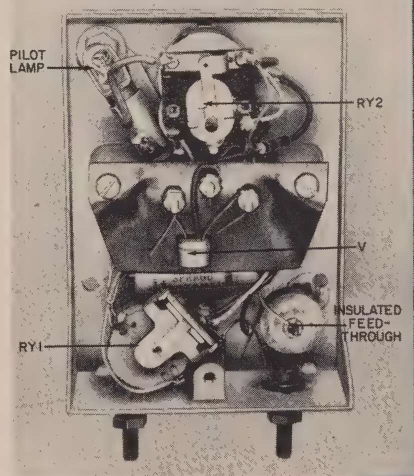
It makes no difference whether the battery returns to the base as in Figs. 1-a and -b or to the emitter as in Fig. 1-c, if the resistance of R1 is much lower than the common-base input resistance of the transistor. Very high alpha is no advantage but a low-current relay and a transistor with low input resistance make a circuit breaker with lower series resistance. Coil resistance up to about 10,000 ohms has no effect but to require a higher voltage. The battery supply (Ea) must be a volt or two more than the relay requires (operating current times coil resistance) but less than the transistor's maximum rating. Keep it as low as possible.

Voltage can be lowest in Fig. 1-a because the polarized relay has less resistance for the same operating current. The unbiased tongue remains tripped without battery drain and is reset by hand or reverse current. Capacitor C makes the breaker trip instead of just buzzing and can be larger if a delay is wanted.

Circuits in Figs. 1-b and 1-c use ordinary plate-circuit relays which operate with a few ma in coils of 2,500–10,000 ohms and are connected to hold on after tripping until reset. They do not need capacitor C if they make before they break, but with make-before-break contacts switch S1 is needed in Fig. 1-b to protect the transistor during switching. A large value for capacitor C delays tripping.



A compact three-terminal breaker opens the negative lead.

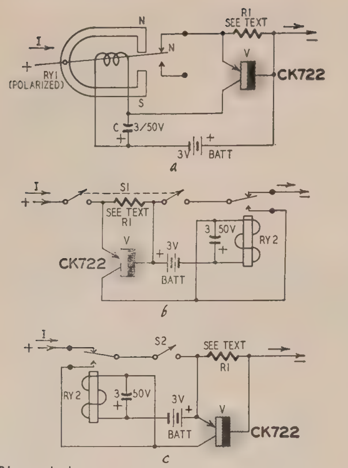


Construction of three-terminal circuit breaker.

Three-terminal breaker

The breakers of Fig. 1 have only two terminals and can be used anywhere like a fuse. Fig. 2 shows the circuit of a compact three-terminal breaker which uses the battery of the protected circuit. It requires a p-n-p transistor if it breaks the positive lead and a n-p-n transistor and reversed electrolytics if it breaks the negative lead. The photos show construction details of the unit.

The sensitive relay in this breaker keys a huskier one with better contacts. There should be several contacts, but the relay that fits the box doesn't have them. Besides, it is better to use independent breakers with circuits that have more than two battery leads.



R1—see text
C—3 µf, 50 volts
Ry 1—polarized relay, 500-ohm coil
Ry 2—nonpolar relay, 2,500 to 10,000 ohms
S1—dpst toggle
S2—spst toggle
V—CK722
Battery—3-22.5 volts

Fig. 1—Three basic circuit breakers.

A pilot light indicates that the breaker has been tripped and, if it burns out, the current through R1 holds the relay without it. The 75 ma drawn by the relay doesn't kill the battery if it is shut off promptly. Ry1 could be a latching relay that holds mechanically instead of electrically, but it would be bigger and cost more.

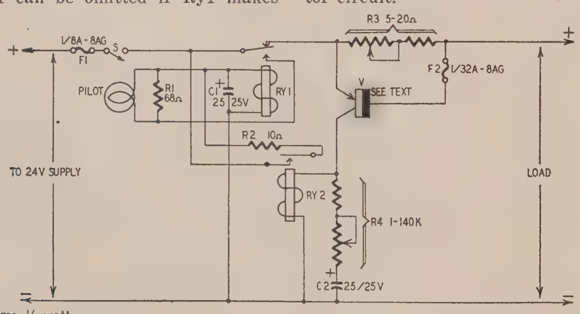
Tripping current and delay are continuously adjustable. C2 delays the tripping longer as R4 is decreased (it can have any one of a wide range of values) and C1 can be omitted if Ry1 makes before it breaks. C1 causes no delay because it is charged directly from the battery through R2, which prevents contact pitting. Where there is chance of accidentally reversing polarity, C1 and C2 should each consist of two capacitors in series back to back, to trip the breaker instead of damaging the transistor or the capacitors. Some electrolytics do seem to work at low voltage with either polarity. To use this breaker with higher currents, just make R3 lower and F1 heavier.

A circuit breaker not only protects the transistors but also warns of amplifier clipping when set to the known overload point and not delayed. It trips on peaks which a milliammeter does not show but which distort the output.

Multistage breakers

Amplification increases the sensitivity, which means lower resistance. You can add alternate p-n-p and n-p-n stages to the simple dc amplifier of Fig. 3 until the amplified cutoff current trips the relay or temperature has too much effect. The gain is low because the first stage operates near cutoff. Bridge circuits would be better and stabler.

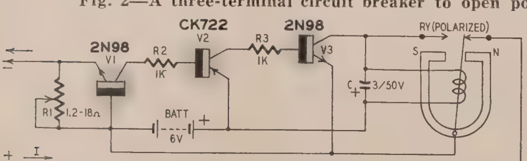
All these breakers need protection against dead shorts. Put a fast fuse heavy enough for negligible resistance in series, and preferably a light fuse in the base lead as in Fig. 2. A 10-ma fuse (263 ohms) cuts the sensitivity of a CK722 or a 2N97 about one-third, so use a 1/32-amp 8AG, whose 40 ohms have little effect. Even a resistor of this size might save the transistor till the other fuse can blow. The relay coil resistance protects the transistor's collector circuit. END



R1—68 ohms, 1/2 watt
R2—10 ohms, 1/2 watt
R3—5-20 ohms, 1/2 watt
R4—1,000-140,000 ohms, 1/2 watt
C1, 2—25-µf 25-volt electrolytic
F1—1/8 amp, 8AG
F2—1/32 amp, 8AG

Ry1—spdt, normally open, 6,500 ohms, closes on 3 ma dc with 22.5-volt battery
Ry2—spst, 320 ohms, 75 ma on 24 volts dc
S—spst toggle
V—CK722, 2N107 for breaking positive lead (see text); 2N97, 2N229 for breaking negative lead (see text)

Fig. 2—A three-terminal circuit breaker to open positive lead.



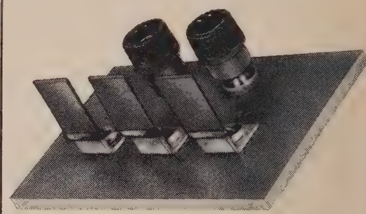
R1—1.2-18 ohms
R2, 3—1,000 ohms, 1/2 watt
C—3 µf, 50 volts
Ry—polarized relay, 500-ohm coil
V1, V3—2N98
V2—CK722

Fig. 3—A multistage circuit breaker.

MULTIPLE SUN BATTERY

By RUFUS P. TURNER

THE dc output of an inexpensive sun battery is too low for most amateur and experimental applications such as supplying the bias for transistor circuits. However, more current or voltage can be obtained by connecting several of these cells in parallel or series.



Completed sun battery.

Readers have several times expressed curiosity as to the performance of a battery of these cells and we decided to make a test to determine the output characteristics. First, it was figured that three cells would be about the largest number the average experimenter would buy. So three International Rectifier Corp. type B2M cells were mounted and connected as shown in the photo and Fig. 1.

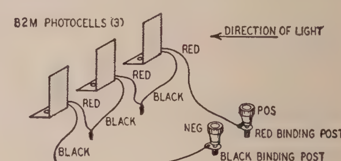


Fig. 1—Pictorial of wiring.

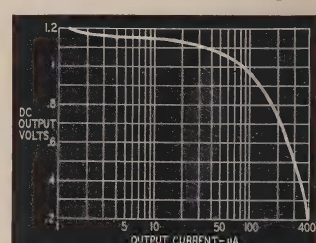


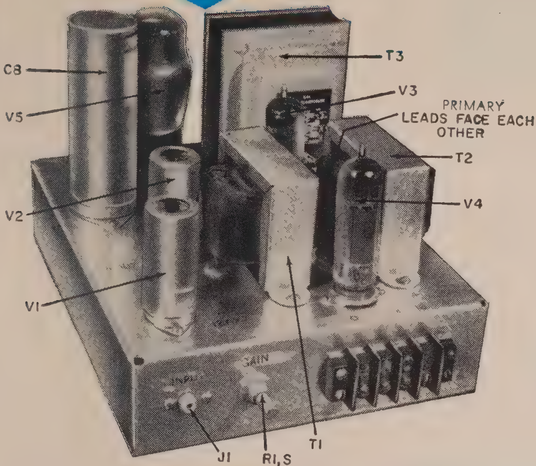
Fig. 2—Output of multiple sun battery.

Fig. 2 shows the dc output characteristic of this three-cell sun battery when exposed to direct sunlight. Note from this curve that the output varies from 1.2 volts at 1.2-μa load (external resistance $R_L = 1$ megohm) to 0.2 volt at 400 μa ($R_L = 500$ ohms). The dc output will be proportionately lower in dimmer light. In the 100–400-μa region, in which most transistor operation probably will occur, there is a variation from 0.2 to 0.97 volt. END

HIGH FIDELITY at LOW COST...with TWIN-COUPLED AMPLIFIER

By NORMAN H. CROWHURST

In this new circuit reproduction is improved by using two *output transformers—without pushing up the price*



Twin-coupled high-fidelity amplifier delivers 15 watts.

SINCE I have written so many articles showing why different amplifiers cause different kinds of distortion and getting straight the way in which different circuits function, I have received a number of calls asking why don't I design a really good amplifier circuit using the best principles discussed. The reason is obvious—I have been too busy investigating and writing. However, it is time for the best principles to be put together into one amplifier. And—in response to popular demand—here it is.

Based on some of the popular misconceptions I have been bucking, some things this amplifier does will be decried by those who have been doing other things. So right here it will be well to explain just *why* the circuit is arranged the way it is:

Investigating different ways of coupling output tubes shows that using push-pull triodes gives the best chance of getting high quality with low distortion. But the output is rather inefficient, unless we go to transmitting triodes and get an output in the region of 100 to 200 watts by working in class B; in which case it is possible to achieve an efficiency comparable to, if not higher than, that obtained at lower powers with pentodes.

Using simple push-pull pentode operation, the circuit is extremely critical of correct matching, which no practical loudspeaker achieves. The circuit is much more efficient in that the tubes give a much bigger output for lower cost, but the stability tolerances of an overall feedback arrangement can become very critical, especially of practical (speaker) loads. Many low-cost "high-fidelity" amplifiers do use push-pull pentodes with some degree of feedback in the output. But they cause their designers numerous headaches in getting distortion down to a satisfactory figure (working into a resistance load), juggling the circuit so it remains stable (if in fact it does) into the variety of possible practical loudspeaker loads and also adjusting the circuit so it *sounds* reasonably good.

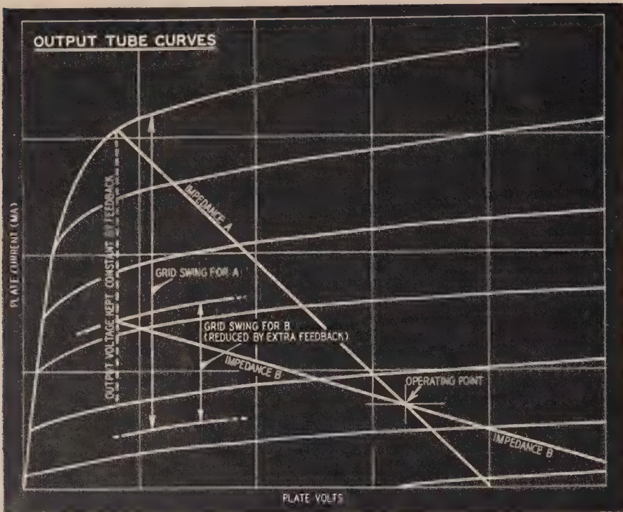
The third alternative is Ultra-Linear. This splits the difference between triode and pentode operation and, in most tubes, also splits the difference in efficiency. As far as the *tubes* are concerned, it is often the best method of operation as regards linearity, but this is not the end of the story. You need a very good output transformer designed specifically for this purpose or other kinds of distortion will show up that the patent specification didn't tell you about.

Unity-coupled

While Ultra-Linear operation makes pentode tubes much more tolerant of different loading, there is another fact about practical operation that allows us to use pentode operation, provided we do it the right way. This is the relationship between a speaker's impedance characteristic and power demand.

At the low-frequency end, where resonance causes a speaker's impedance characteristic to rise, resonance improves its electromechanical efficiency. What is needed is virtually constant *voltage* drive, rather than constant *power* drive. Less power is required if the speaker is matched to the amplifier in the region where its impedance is substantially resistive (see Fig. 1-a). This means that, although pentodes normally produce more distortion working into a higher load, we can utilize this impedance drive to reduce distortion by a greater ratio than the rise in impedance. The reduction in power demand from the output then results in a satisfactory distortion figure.

Reactive components in a speaker's impedance characteristic at the high-frequency end have a similar factor to help them. A speaker works best when fed by a constant voltage or high-damping-factor amplifier and, in most



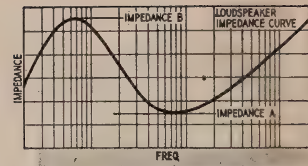


Fig. 1-a (above)—Speaker impedance varies with frequency. Fig. 1-b (left)—Properly applied voltage feedback can improve performance of pentodes into a speaker load without losing advantage of better efficiency.

program material, there is very little power at the extreme high frequencies. An amplifier using pentode output and a feedback arrangement that readjusts the tube operation to compensate for this (Fig. 1-b) and that delivers full power into a nominal resistance load over the entire audio-frequency range, will perform at least as well as the Ultra-Linear. It will be more efficient because pentode operation is still more efficient than Ultra-Linear, especially with class-B operation.

This is the philosophy behind two popular circuits, the unity-coupled by McIntosh and the Circlotron by Electro-Voice. The unity-coupled circuit uses a special output transformer, a vital feature of which is the bifilar winding of the primary. None of the transformer manufacturers produces a transformer for unity coupling, with a bifilar-wound primary. If they did, its cost would put unity coupling off the map for most amplifier builders. McIntosh can produce a competitive amplifier with this circuit only because they make their own transformers on a production line, integral with the manufacture of the amplifier itself.

The Circlotron is a circuit that is also specially adapted to production by a manufacturer who specializes in this type. The output transformer is not unusual (beyond having an unusual ratio), but the power transformer has to be because the circuit requires two separate high-voltage supplies.

Twin-coupled circuit

In the circuit I use, which I propose to call the twin-coupled circuit, instead of using two separate high-voltage supplies, or a very special bifilar-wound output transformer, I use a conventional power supply with two conventionally wound output transformers of moderate cost. The cost of these output transformers is such that two of them can be obtained for less than the one found in more conventional high-quality amplifiers.

This is made possible by the use of a circuit which does not require output transformers to respond to frequencies far beyond the actual audible frequency range required, *merely to satisfy stability criteria* of the feedback circuit. It has always seemed to be a waste to require an output transformer that maintains response flat to somewhere between 100 kc and 1 mc to amplify satisfactorily frequencies that go up to only 20 kc.

The next question is how big are we going to make this amplifier? For the first model we decided to use a couple of EL84's to deliver a maximum output of 10–15 watts. This amplifier will deliver about 10 watts rms continuous sine wave. In practical audio program material it delivers the equivalent of 15 watt rms undistorted and 30 watts peak with slightly less than 1 volt input. This is because, when a continuous maximum output is passed, the B-plus voltage drops off a little and reduces the available power. So for performance comparison purposes this can be called a 15-watt amplifier.

The reason so small an output proves satisfactory is that it does not run into sudden kinds of distortion when the output is exceeded on momentary peaks. Careful observation and tests with various amplifiers of different power ratings have shown some interesting facts. Many circuits designed to deliver 50 watts or more probably deliver their rated output with very low distortion. But try to get 51 watts from a 50-watt amplifier and you will suddenly find you are getting only about 35 watts of *distorted* output.

This explains a fact that many have already noticed: that some lower power-output rated amplifiers give apparently cleaner and better output than those with a bigger rating according to specification. Suppose we have an audio program run at an average level of, say, 5 watts, with peaks extending up to what should require 60 watts.

Using a 15-watt amplifier of good design, the average level will be pure and undistorted at 5 watts. The 60-watt peak will be slightly distorted, but clipped down to about 20 watts instead of 60. The overall result does not sound too bad.

Now the same apparent level from the 50-watt amplifier will sound considerably worse. The average 5-watt output, *by itself*, would sound the same as from the 15-watt amplifier. But the 60-watt peak drives the 50-watt amplifier into very severe distortion, so as to give only about 35 watts extremely distorted output. Not only this, but the distortion hangs over into the 5-watt level that immediately follows the 60-watt peak. Consequently even the average 5-watt level is much more distorted than it sounds in the well designed 15-watt amplifier.

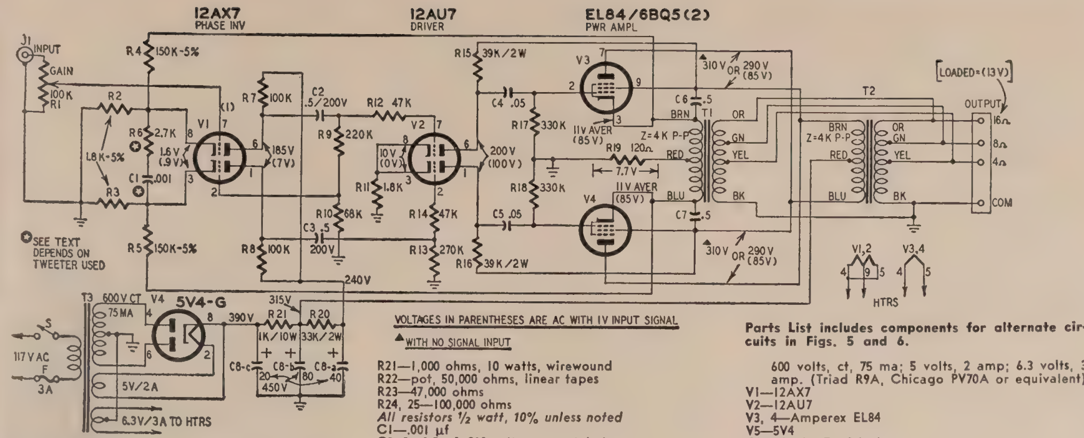
To make the 50-watt amplifier sound as clean as the 15-watt amplifier we have to turn the gain control down so the peaks stay well below 50 watts, which means we shall no longer have the average operating level of 5 watts. Consequently the output will not sound as loud as it does from the 15-watt amplifier.

Based on this experience, the twin-coupled amplifier eliminates the causes of sudden-overload distortion and, surprisingly enough, gives performance that compares with many 50-watt amplifiers very favorably, although it is capable of delivering only 30 watts peak undistorted and 10 watts rms.

Circuit details

My circuit uses cathode bias. This is not an essential feature of the twin-coupled circuit but is thought best for this particular tube combination because the EL84 is rated to give 17 watts from a pair, either in class AB_1 with cathode bias or in class B with fixed grid bias. Use of the class-B arrangement would improve power supply economy and possibly allow a bigger reserve power against maximum measured power—if this is an advantage. The disadvantage is that class-B operation with fixed bias runs us into that sudden-overload trouble.

There are ways of overcoming this problem by using extra tubes in the



R1—pot, 100,000 ohms, audio taper, with spst switch
R2, 3—1,800 ohms, 5%
R4, 5—150,000 ohms, 5%
R6—2,700 ohms, 5%
R7, 8—100,000 ohms
R9—220,000 ohms
R10—68,000 ohms
R11—1,800 ohms
R12, 14—47,000 ohms
R13, 26—270,000 ohms
R15, 16—39,000 ohms, 2 watts
R17, 18—330,000 ohms
R19—120 ohms, 2 watts
R20—33,000 ohms, 2 watts
R21—1,000 ohms, 10 watts, wirewound
R22—pot, 50,000 ohms, linear tapes
R23—47,000 ohms
R24, 25—100,000 ohms
All resistors 1/2 watt, 10% unless noted
C1—.001 µf
C2, 3—0.5 µf, 200 volts, paper tubular
C4, 5—.05 µf, 600 volts
C6, 7—0.5 µf, 600 volts, paper tubular
C8—40–80–20 µf, 450 volts, electrolytic, can type
F—Fuse, 3 amp
J1, 2—phono jacks
S—spst switch on R1
T1, 2—output transformers, 7½ watts, 4,000 ohms, plate to plate ct: 8-, 16-, 32-ohm secondary (Chicago Standard A-8094, Thordarson Meissner 22S21, Merit A-2997, Triad S-34X
T3—power transformer: primary, 117 volts; secondary, 600 volts, ct, 75 ma; 5 volts, 2 amp; 6.3 volts, 3 amp. (Triad R9A, Chicago PV70A or equivalent)
V1—12AX7
V2—12AU7
V3, 4—Amperex EL84
V5—5V4
Chassis, 9 x 7 x 2 inches
Sockets, 9-pin shielded (2)
Sockets, 9-pin unshielded (2)
Socket, octal
Fuse extractor post
Barrier strip, Cinch-Jones 4-141 or equivalent
Grommets, ⅜ inch (4)
Grommet, ¼ inch
Tie strip, Cinch Jones 52A
Tie strip, Cinch Jones 53C (one mounting lug removed)
Miscellaneous hardware

Parts List includes components for alternate circuits in Figs. 5 and 6.

Fig. 2—Circuit of the twin-coupled amplifier.

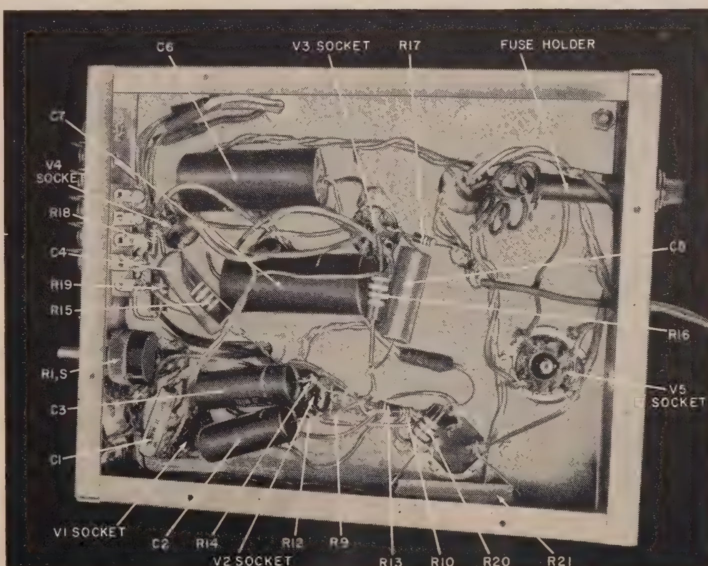
circuit, but, for the purpose of this amplifier, as class-AB operation gives the same output as class B, the simpler method (and the cheaper one) is to switch to cathode bias and use class AB. Fig. 2 is the amplifier schematic.

The next point involves the choice of phase inversion. One idea considered was to use the 12AX7 with one half operating as a split-load phase inverter. This would enable single-ended feedback to be used, which was one reason for abandoning it. As we shall see, there are advantages to the use of entirely push-pull feedback in this circuit. The other reason is that the split-load phase inverter comes immediately before the 12AU7 driver (V2), which has boot-strap coupling in the plate circuit to get enough swing to drive the output tubes. This means that the input grid swing to the 12AU7 on each half is just about the maximum possible by the time you reach maximum output from the EL84's. Under this condition a split-load phase inverter introduces a rather curious distortion and one which overall feedback tends to exaggerate rather than minimize.

When the grid of the 12AU7 coupled to the cathode of the split-load phase inverter begins to conduct, as it will if peak output is even slightly exceeded, it clips the waveform, the same as with any other grid current in an R-C-coupled circuit. But, as well as clipping the waveform of the drive stage coupled to the cathode, it produces a very sharp peak in the waveform fed to the other half of the 12AU7. This is because the cathode half of the split load is virtually bypassed by zero impedance as soon as grid current begins to flow in the tube it drives. This means that the tube begins to operate into the plate half of the load as a full amplifier, instead of a split-load inverter. Consequently a sudden, very sharp pointed peak, in a negative direction, appears in the plate circuit (Fig. 3).

All of this begins to happen at about the same time other circuits reach overload points. The effect of feedback is to exaggerate this sharp peak. It takes a variety of forms at different frequencies. Some places appearing as a notch, at other places it begins to look like a damped parasitic oscillation on the waveform. This is shown by Fig. 4.

This defect can be avoided by using push-pull operation throughout, which is the circuit I finally adopted. A further advantage of using push-pull operation throughout is that it allows entirely push-pull feedback. This means the output transformers can be removed from the feedback loop. Some will immediately object that this means the



Underchassis view shows the relatively uncluttered wiring.

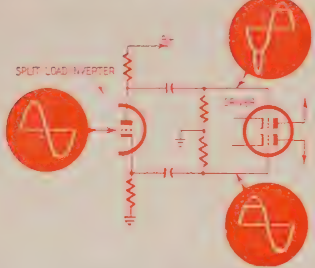


Fig. 3—Waveform distortion due to split-load and other inverters, when operated to maximum swing of following stage.

feedback does not cancel distortion "produced by" the output transformer. This is not true, as I have shown in previous articles.

Output transformers cause distortion in two ways: by the direct effect of the magnetizing current at low frequencies or due to their internal reactance at very high frequencies.

Usually the latter effect is produced, only due to the method of operating the tube or due to overall feedback. Consequently, removing the transformers from the overall feedback loop, rather than allowing them to produce distortion at the high-frequency end, frees them from the liability of doing so and also makes it possible to use a transformer that does not have to respond up to 100 kc or higher to produce satisfactory performance up to 20 kc.

At the low-frequency end, feedback from the primary is as effective in reducing distortion due to transformer magnetizing current as feedback from the secondary. So, by using overall feedback from the output tubes back to the input 12AX7, we avoid the need for *unnecessarily* high-quality output transformers and produce an amplifier which is inherently more stable than any kind of circuit with output transformers in the feedback loop.

In this circuit it is important to have close tolerance values for feedback resistors R2 and R3 in the cathodes of the 12AX7 and R4 and R5 from the cathodes of the EL84's. These resistors should be 5% tolerance or better.

The phase-inversion circuit is somewhat new, although it looks like a straight paraphase. It is different because the overall feedback operation is included in phase inversion. If the inversion provided by resistors R9 and R10 is not exact, overall feedback will correct for this.

The use of a paraphase inversion is still liable to produce an effect similar to that described with the split-load phase inverter. The presence of overall feedback in push-pull minimizes the effect, but it still can increase the distortion a little before the clipping point is reached, due to the fact that 12AU7's do not start to conduct grid current suddenly.

The remedy for this is to insert resistors R12 and R14 in series with the 12AU7's grids. This prevents the slight grid current commencement at pin 7 of the 12AU7 from being reflected into the 12AX7 grid at pin 2 and producing an asymmetrical signal through the amplifier. Instead the signal fed to pin 2 of the 12AX7 is a true inversion of that at the input, pin 7. The slight droop at maximum signal, due to the very small commencement of grid current through R12 and R14, is symmetrical and readily compensated for by the feedback arrangement, until clipping occurs on the output tubes.

Checks with the indicated values for R9 and R10, used for phase inversion, show that close tolerance is not critical. The closely controlled push-pull feedback takes care of slight fluctuations at this point. Serious deviation from the correct values, such as using 47,000 or 100,000 ohms in place of 68,000 ohms, will result in unbalance in the drive to the 12AU7 and consequent un-

Fig. 4—Two waveforms resulting from the effect of Fig. 3 working in a feedback amplifier.

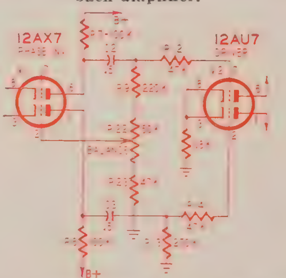


Fig. 5—Circuit shows how to add a balance control.

balance in the drive to the EL84's. This will be approximately equalized in the output due to the transformer and cross-coupling action, so the fed-back signal gets almost equalized by the time it reaches the cathodes of the 12AX7. The degree of unbalance in the drive to the 12AU7 and EL84's will be less than the degree of error in the phase-inverter values. Due to feedback action, the fed-back signal at V1's cathode will be unequal to compensate for the inequality the phase inversion tends to produce.

But to produce maximum output and avoid a form of notch distortion, which may show up above 3,000 cycles, it is best to use the indicated values for R9 and R10, as well as close-tolerance feedback resistors. If you want to incorporate a refinement to be sure of obtaining absolutely the best performance from this amplifier (and some people always like to have a BALANCE control in a push-pull amplifier) use a 50,000-ohm potentiometer in conjunction with a 47,000-ohm resistor in the phase-inverter circuit. This circuit is shown in Fig. 5. Adjust the BALANCE control for equal voltages on the grids of the 12AU7, at a 1,000-cycle input signal.

Another comparatively minor advantage of this amplifier circuit is that it readily lends itself to modification to push-pull input. This has some advantages if you wish to operate the amplifier with a compressor, expander or coded controls, using variable-gain stages ahead of it. These circuits work with much less distortion if the variable-gain tubes are used in push-pull so as to give a push-pull output. In using this amplifier, it is then possible to use push-pull coupling throughout. All that is necessary to make the change is to remove the phase-inversion components, put another 270,000-ohm unit in the grid circuit to pin 2 of the 12AX7 and bring out another input lead. This is shown in Fig. 6.

How it works

Now come the points that everyone wants to know—how this amplifier really works. It uses two output transformers, the primary of one being in the cathode circuit while the primary of the other is in the plate and screen circuits, with these cross-coupled. The secondaries are connected in parallel, not only at the ends but at each tap. This means that whichever secondary tap is used, half the output current will be delivered by each transformer.

On the primary the same resultant current flows through both transformer windings because they are virtually in series. The high voltage goes in at the center tap of one, through the tubes and out through the center tap of the other from the cathodes. So half the audio voltage is developed on each output transformer's primary.

For the extremely low frequencies, magnetic coupling from one primary to the other by the parallel-connected secondaries is sufficient to insure that screen voltage is always in phase with cathode voltage and that plate voltage is equal but in opposite phase on each tube. To take care of the middle and higher frequencies, where the leakage inductance of the transformer would loosen off this coupling, the simple expedient of placing a 0.5-μf capacitor between screen and cathode of each tube is used. This means that good coupling

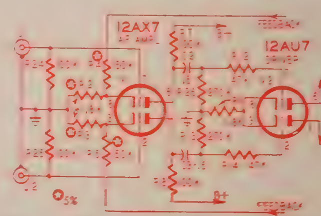


Fig. 6—Circuit modification provides push-pull input.

in the tube is maintained out to a frequency far beyond that possible in an output circuit of this type where the correct maintenance of voltage between screen and cathode depends on transformer coupling.

Here many will ask, "Why, if you are using a low-cost transformer of conventional construction, do you have to get one specially made?" This was something I hoped to avoid. But everything I could find listed had to be rejected for one of two reasons.

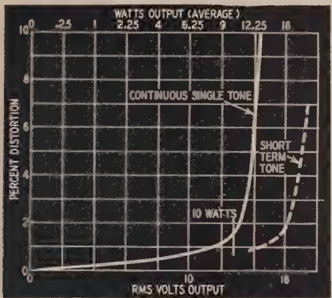


Fig. 7—Distortion characteristic: for continuous tone and short-term power demand. Harmonic content below the sharp upward turn is almost entirely second, negligible third and higher order.

Single-ratio transformers in this power rating (7.5 watts per transformer, since each delivers *half* the total) do not have the right impedances. As we have explained, the primary of *each* transformer presents half the normal plate-to-plate load for these tubes. Also the *nominal* secondary impedance needs to be twice that of the speaker system to which the two are connected, as they supply the total power in parallel, between them.

Some of the so-called "universal-output" transformers might include the correct impedance ratios. But these types are invariably intended for even poorer frequency range than we can tolerate. While complicated design, to get an unnecessary high end response, can be avoided, we still need *iron* to get the low end. Most of the universal type list a weight of less than 1 pound, which means they could never give power below 60 cycles—if they go that far.

For this reason, I designed a suitable transformer for the job (although two transformers are used, they are identical) and had them made up. Having proved that the amplifier works up to expectations, a number of well-known transformer manufacturers have agreed to cooperate with readers of this magazine by making this type available and the suitable new type numbers are listed in the parts list.

If you should have a couple of old transformers lying around that you would like to try in this circuit, remember that the plate-to-plate load must be *half* the normal value for the tubes, and the secondary rating for impedance must be *double* the speaker impedance with which you will use it.

As feedback is taken directly from the cathode, which is only at a low voltage above ground, it is unnecessary to use blocking capacitors in series with feedback resistors R4 and R5. This eliminates a potential cause of low-frequency instability.

Cathode degeneration, due to half the power being taken from the cathode circuits of the EL84's, reduces the effective voltage gain of these tubes as output tubes by about 12 db, operating into correctly matched load. (Operating open circuit, this would be a reduction of about 35 db.) This means damping factor, before any *overall* feedback is applied at all, is equal to approximately 3 or 4.

The boot-strap circuit has the effect of increasing the dynamic load line for V2 by a corresponding factor of 4 times due to the 12-db degeneration in the output stage. This more than doubles the available swing from the 12AU7, but it does not have the effect of degenerating the distortion-reducing effects of negative feedback by the same factor.

This is because V2's *gain* is not boosted by the same amount as its available *swing*. Working with the 39,000-ohm plate resistor, V2's gain, with a plate resistance of about 7,000 ohms, comes out to 39/46 times the amplification factor of the tube, which is 17. This figures to about 14.4. Using the dynamic load of 4 times 39,000 ohms, or approximately 160,000 ohms, the gain of the tube rises to 160/167 times the amplification factor of 17, or about 16.3. So the change in gain, due to the boot-strap effect, is from 14.4 to 16.3, which is little more than 1 db.

Another comment on this circuit may refer to the absence of cathode-bypass capacitors, on either the 12AU7 or EL84 bias resistors. In both instances, the use of a cathode-bypass capacitor not only increases the distortion produced by the pair of tubes, but also reduces the available swing as compared with the unbypassed condition. Thus leaving out the bypass capacitors is not a matter of economy, it produces better performance.

With the 12AU7 boot-strap drive circuit, the damping factor of this amplifier is still in the region between 3 and 4 (a little nearer to 3 than to 4). The overall feedback provided by the 150,000- and 1,800-ohm resistors is around 14 db, which boosts the basic damping factor of the amplifier by 5 times, to about 15. Winding losses in the output transformers reduce this, at the output terminals, to between 8 and 10, according to the tap used. As the winding losses in the transformer are still only a small fraction of the speaker's voice coil resistance, this cannot be regarded as a serious deterioration in damping.

From the feedback viewpoint, the overall feedback loop contains three rolloffs at the low-frequency end of the response. The reactances contributing to this rolloff are C2, C3, C4, C5 and the primary inductance of the output transformers, the latter being the limiting factor. The other values are optimized to minimize possible bounce effects with any practical load reactance possibilities. This produces level response down to 20 cycles.

At the high-frequency end, cathode degeneration of the EL84's prevents either plate or cathode circuits from introducing any effective rolloff up to a much higher limit than that produced in the other circuits. The effective rolloffs are due to the V2 grids as a capacitance loading on the plate circuits of V1 with the 47,000-ohm resistors in series, and due to the EL84 grids as a capacitance loading on the plate circuit of the 12AU7. Without any compensation, the overall response of the amplifier is level up to well above 10 kc, although there is a loss of about 1 db between 15 and 20 kc.

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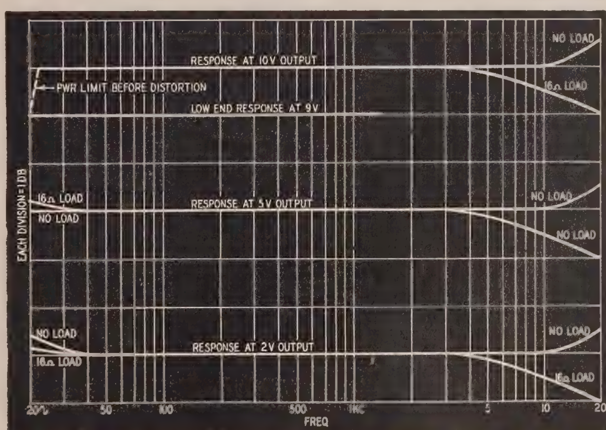


Fig. 8—Frequency response at different levels: measured with continuous tone. Taken with R6–C1 connected. Operation into dynamic speaker or combination with dynamic tweeter comes out nearer to flat than either high-end curve. For electrostatic tweeter (without internal compensation of any kind) and R6–C1 removed, response is about ± 2 db at 20,000 cycles, according to tweeter referred capacitance.

LOUDSPEAKERS ...of the future

By GERALD SHIRLEY

A glimpse of how tomorrow's loudspeakers may look and operate

IN the field of transducers which convert electrical energy into acoustical energy, the long-held supremacy of the cone type speaker is being challenged by new types of loudspeakers. Principally these are electrostatic, Ionophone and Corona Wind.

Strictly speaking, electrostatic speakers are not new; their theory was well understood long ago; in fact there were one or more commercial versions as far back as the Nineteen Thirties—Kylectron, manufactured by United Reproducers. These early models suffered from arc-over, dielectric breakdown and limited performance due to a lack of suitable materials in those days. As a result they dropped out of competition. In recent years the development of myriad new materials and plastics has made possible the successful revival of the electrostatics. In their push-pull, high-fidelity versions—notably JansZen and Pickering—they have already won many adherents among audiophiles.

The Ionophone was first demonstrated by Sigfried Klein, the French scientist, several years ago. This tweeter was probably the first sound-producing transducer having no moving parts. Commercial versions of the Ionophone have been in use in France for several years, principally in theaters, and production in Germany and England by licensees is reported to have begun last year. In the United States the rights to the Ionophone were acquired by the DuKane Corp., and, after a year of intensive research under the direction of their chief engineer, William Torn, working with the inventor himself, the company has announced an improved model. Electro-Voice Co. will distribute the home hi-fi version for DuKane; its price is about $150. The American version of the Ionophone has been renamed the Ionovac (see Fig. 1) and is made by Electro-Voice. (The etymology of this rechristening appears somewhat obscure since the suffix vac usually connotes the word vacuum.) How well the Ionovac tweeter will be received by the Golden-Ear crowd remains to be seen, although it seems reasonable to expect that the quality of reproduction should be excellent.

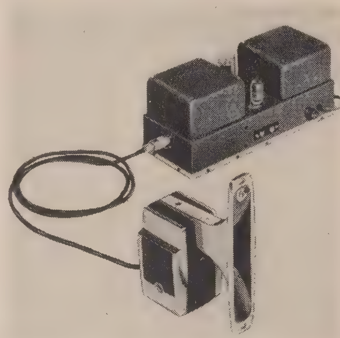


Fig. 1—The Electro-Voice Ionovac.

Corona Wind loudspeaker

The newest development in the speaker field is the Corona Wind loudspeaker (CWLS). Like the Ionophone it has no moving parts. However, it has the additional advantage of being inherently a wide-range transducer, with response right down to zero cycles. The CWLS is the invention of a New Zealand-born engineer, Dr. David M. Tombs, who began his work on the speaker several years ago while senior lecturer in tele-

HI-FI TWIN-COUPLED AMPLIFIER *(Continued)*

Use of resistor R6 and capacitor C1 between V1's cathodes levels off the response to 20 kc, working into a resistance load or open circuit.

The circuit as shown will work well into any dynamic speaker combination. But for a system with an electrostatic tweeter it will produce from 6–8-db boost at about 20 kc. This can be reduced to about 2 db, which will sound quite smooth, by omitting R5 and C1. Distortion characteristic and frequency response are shown in Figs. 7 and 8. The 2 db can be eliminated by inserting a resistance about half the value of the nominal impedance (8 ohms on the 16-ohm output) in series with the tweeter feed. This will affect only the 20-kc response.

Construction kinks

C6 and C7 should be arranged to get as direct a coupling as possible between cathode and screen. This is achieved by spacing the tube sockets so the capacitors may be wired directly and snugly into this position. The output transformers are then oriented to keep all primary leads short. These are the only precautions necessary in chassis layout to insure stability.

In this amplifier circuit, ground returns are no problem at all as regards stability. But careless ground returns can result in slight hum induction. This conforms with the general pattern of precautions for power amplifier wiring. C8 may have its case directly grounded to the chassis, in which case the input ground should be isolated from chassis and a return taken to the point where the supply goes to ground at the electrolytic capacitor. Alternatively the electrolytic capacitor may be isolated from ground by using the bakelite wafer that comes with it, in which case the input socket can be solidly grounded and a return taken from the supply ground back to the input. All other amplifier grounds should then be taken to the supply ground rather than the input ground, to avoid internal ripple coupling back to the input. These precautions are necessary only if you are aiming to get a hum level in the region of 90 db or even better.

This is the first constructor amplifier utilizing the new twin-coupled output circuit. The circuit is not, of course, restricted to application to EL84 tubes. For bigger outputs class-B operation could be utilized with suitable transformers for the purpose and a method of coupling between the drive and the output stage that obviates the sudden overload characteristic of class-B unity-coupled operation. If interest in a higher-output twin-coupled amplifier warrants it, we will pursue the matter and publish later a design for a further circuit with bigger output. END

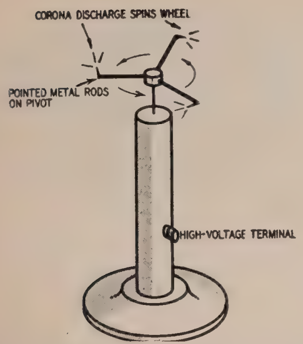


Fig. 2—Physics experiment shows effect of corona wind. The wheel spins exactly as if air were jetting out of each point.

communications at the Imperial College of Science and Technology of London University. At present, Dr. Tombs is director of research at Hoover, Ltd., an important British manufacturing concern.

In this article I will explain the theory of the CWLS, discuss its present and potential characteristics and compare it with the other new types of speakers. There will be no discussion on the theory and construction of Ionophone and electrostatic speakers, as RADIO-ELECTRONICS readers are already familiar with them. (Articles on the Ionophone appeared in RADIO-ELECTRONICS, November and December, 1951. Articles on electrostatic speakers appeared in RADIO-CRAFT, December, 1929, and January, 1930, with shorter items on the newer electrostatics scattered through the past few years.)

The basic phenomenon which makes the CWLS possible is corona wind. Whenever there is a corona discharge, it is accompanied by a movement of air away from the discharge point. Fig. 2 is a physics experiment used to show this action. Corona discharge from a sharp point is a product of high voltage and is made possible by ionization of the air—the air actually becomes conducting. For reasons not yet completely understood, the wind which emanates from a corona discharge point having a positive voltage appears to be stronger than the wind from a negative point.

Once the possibility of producing a wind exists, then there is the possibility of producing sound if a method of modulating that wind can be found. It is no trick to modulate wind mechanically through the use of a fast-acting valve, and in fact such devices have been used with compressed air to produce very powerful PA systems. However, this is *not* the way to get high fidelity. Dr. Tombs reasoned that, since the flow of corona current and the movement of wind were directly related, it should be possible to control the wind indirectly by controlling the current. To test this theory he mounted a smooth, round ring in the vicinity of a corona-discharging electrode and found that by adjusting its position and voltage it could be made to behave very much like the grid of a vacuum-tube triode. As shown diagrammatically in Fig. 3-a, this is actually an embryonic loudspeaker. Note that the collector electrode or anode is blunt—that is, it has a smooth, broad surface. With this type of electrode structure the ac sound component is superimposed on a steady, undirectional wind; the electrical analogue would be modulated dc or ac with a dc component. To eliminate this background wind, which serves no useful purpose and would probably be distracting if audible, Dr. Tombs next tried using a sharp electrode for the anode. This produced its own wind which opposed the wind from the cathode and it was found possible, by adjusting the voltage and position of the grid, to achieve a state of no wind with zero input signal. (See Fig. 3-b.)

This is the form which has been utilized in making small prototype speakers for laboratory studies and demonstrations of the device. It can be seen from Figs. 4 and 5 that a great many pairs of needles are used; the reason for this is simply that the amount of sound produced by a single pair is very faint. It has been estimated that for the average living room a needle field having an area of between 2 and 4 square feet will be required.

The Corona Wind loudspeaker appears to possess several significant virtues. Most of these arise from the fact that there are no moving parts, hence no resonances or nonlinear suspension problems such as are encountered in conventional cone and diaphragm speakers and drivers. The frequency response goes right down to zero and extends well up into the ultrasonic region at the upper end. The response curves taken on the early experimental models are not yet absolutely flat but it is expected that, since flat response is theoretically possible, further research and development should make it a reality.

Speaker comparison

It is interesting to compare the Corona Wind loudspeaker with the Ionophone and electrostatic types, since there are both common characteristics and differences between them. Taking the Ionophone first, the most conspicuous similarity is, of course, the absence of moving parts. Both types require a high voltage. The Ionophone is powered and driven by an rf, amplitude-modulated transmitter. The CWLS is powered by a high-voltage dc power supply and driven by an audio signal of high peak-to-peak voltage, but no audio watts are required. The Ionophone is a point source of sound and requires a horn to couple its output to the room air load. The CWLS is an area device and requires no coupling mechanism or transformer. However, when it is to be used as a full-range reproducer, it will require suitable baffling just like any woofer to preserve the low-frequency response—to prevent cancellation effects between front and back waves. (Either an infinite baffle or a bass-reflex enclosure should work properly with the CWLS.)

The Ionophone appears to be inherently a single-ended transducer. According to published graphs, its distortion varies inversely with frequency and this is perhaps the most important reason why its use is limited to tweeter applications. (The other reason, of course, is the horn problem.) The CWLS in its single-ended forms, as shown in Figs. 3-a and 3-b, is subject to square-law distortion in much the same manner as single-ended electrostatic speakers. Fortunately it is very easy to recast the CWLS in push-pull form (see Fig. 3-c), significantly reducing distortion.

The Ionophone is said to generate considerable internal heat, which may necessitate occasional replacement of the quartz cell. The CWLS, on the other hand, generates ozone which is corrosive to many metals. It would probably be desirable in a commercial CWLS to have the electrodes and grids made of a corrosion-resistant material such as stainless steel.

Lastly, the Ionophone appears to operate as a power diode whereas the CWLS operates as a power triode. This woud seem to imply greater efficiency for the CWLS.

Turning now to electrostatic speakers (Pickering makes one called the Isophase, see Fig. 6), the first point of similarity to the CWLS is that both are area devices rather than point sources of sound. This particular characteristic of sound-producing transducers appears to be taking on more importance recently. This may have something to do with the increasing interest in and growth of stereo (and pseudo-stereo) reproduction. All other things being equal in a high-fidelity

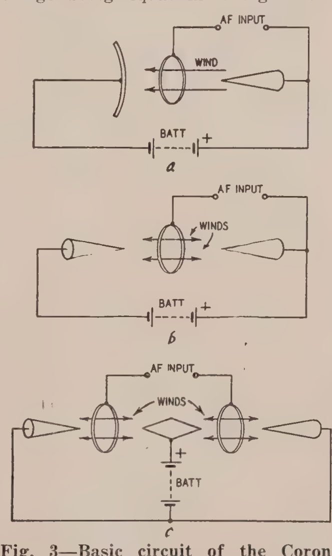


Fig. 3—Basic circuit of the Corona Wind loudspeaker.

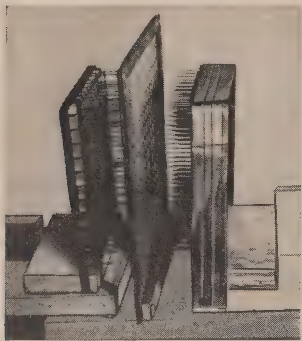


Fig. 4 (left)—One of first experimental Corona Wind speakers.

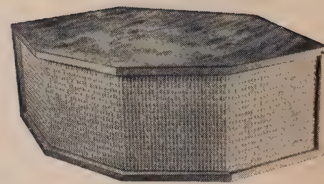


Fig. 7—The Jans-Zen electrostatic speaker.

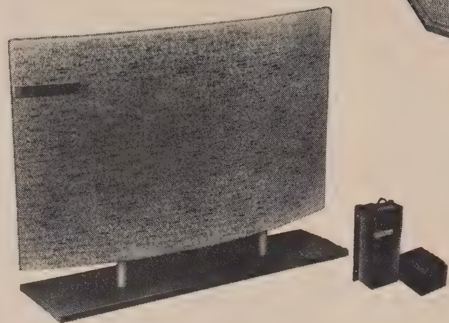


Fig. 6—Pickering's Isophase, an electrostatic loudspeaker.

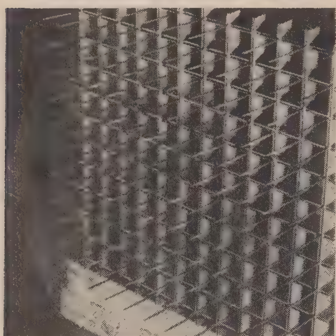


Fig. 5—Closeup shows one of needle fields used in Corona Wind speaker.

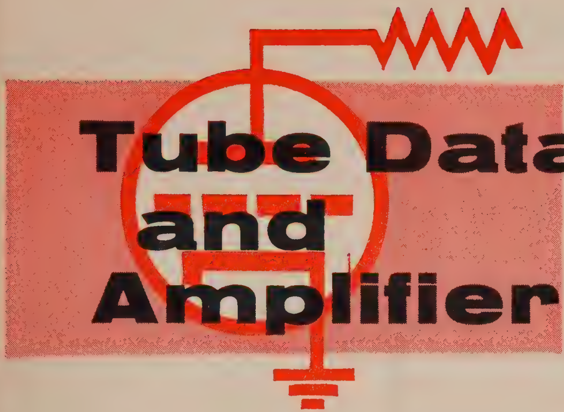
single-channel system, if the middle and upper-middle frequencies are generated by a large area reproducer, the reproduction just seems to sound better than when the source is small.

The electrostatic speaker utilizes a high voltage, too, but its characteristics and function are quite different from the other two types. In the electrostatics the voltage is used for polarizing the field, the potential is kept below that which would cause ionization and very little current is drawn. The power to drive the electrostatic speaker must be in the form of actual audio watts. (This creates something of a problem for some amplifiers since the load seen by the output tubes is almost pure capacitance.)

The lightweight diaphragm of the electrostatic speaker comes fairly close to the no-moving-parts ideal of the CWLS and Ionophone, but still imposes certain limitations on the speaker's performance. At the high end this limitation is not immediately apparent since fairly flat response to 20,000 cycles or higher has been achieved. The significant fact here, though, is that different makes of electrostatic speakers do sound different from each other and this is evidence that the diaphragms are somewhat coloring the output, no matter how slightly. As long as this is so, it is hard to see how the claim—made in certain quarters—that the output is absolutely indistinguishable from the original sound can be sustained. The current push-pull electrostatics represent a marked advance in the art and to many listeners are an improvement over cone and compression type tweeters. But until the Ionovac and CWLS have also been heard from, no speaker should be accorded the title of ultimate.

At the low end of the frequency spectrum, the limited amplitude of excursion of its diaphragm makes it difficult for the electrostatic to perform effectively—to move a lot of air. The limits on diaphragm excursion are dictated by the necessary methods of suspension and even more so by the close proximity of the polarizing plates. The only out for the electrostatic that wants to woof is to grow bigger, but obviously there are limits here too. Since the CWLS does not have a diaphragm, it is apparently not as severely limited in this respect and should be able to move considerably more air at low frequencies than an electrostatic of the same overall area. Several wide-range electrostatics have been developed and demonstrated. I have heard two models so far and they are not in the same league with Klipschorns, AR's or even a good bass-reflex job. If you want that frightening whomp from a bass drum (with the volume turned up a little, of course) or that semi-earthquake feeling which a 32-cycle (or lower) organ pedal tone can generate, you'll stick with your old-fashioned cone type woofer for the time being. Time will tell whether with further improvements the electrostatics can equal these older types, and whether the Corona Wind loudspeaker too can equal and perhaps even surpass them.

So much for comparisons. It must be pointed out in closing that, while the electrostatic and Ionophone types are already available, the CWLS is still in the experimental stage and considerable research and development will be necessary to bring it out of the laboratory and into the home. The research will have to start at a very elementary level since little is known about this aspect of corona—the associated wind. The effects of all the variable parameters—shapes and sizes of electrodes and grids, spacing, positioning, voltages, etc.—have to be studied individually and then in combination to find the optimum design centers. (Some of this research has already been started in various universities.) Since at the present time there is no timetable on the CWLS, you are advised not to put off assembling your dream systems until you can obtain one. It will probably be several years at least before they are available. END



Tube Data and Amplifier Design

Part I—How to use available tube data for R-C-coupled pentode amplifier design

By **HERBERT RAVENSWOOD**

DESPITE manufacturers' efforts in preparing tube manuals, we sometimes need data that is not there. This article shows how to make the best of what is given.

The variety of circuits in which tubes are used and the ever-enlarging range of tube types make presenting adequate information about their performance in different circuits quite a problem for the tube manufacturers. In spite of the ever-growing variety, and the good job done in supplying data, we sometimes find it hard to locate a tube with just the right combination of characteristics to suit the purpose we have in mind. When we find a tube that looks about right, often the manual we are using does not present the information in an easy form to apply to our problem!

I have no less than a dozen tube manuals, of which more than half are the type maintained as a service in a loose-leaf binder. Even with this comprehensive data, I sometimes have to interpolate and figure out what I want by "inspired guesswork." But before proceeding with "how to make good guesses," some readers will want to know what is the best tube manual.

Some tube manuals

Probably the best buy, value for money, is the *RCA Receiving Tube Manual*, at 60c. The current edition includes 20 tabular charts of information about R-C-coupled amplifiers, covering 56 tube types, pentodes and triodes. These charts give all the essential data for three B-supply voltages, with three plate-coupling resistor values for each. A selection of three grid resistor values for the following stage with each coupling resistor is also provided. This means a total of 27 sets of operating conditions for each chart. Each lists values for the remaining resistors in the circuit, the voltage gain achieved and the maximum output available, together with capacitor values for a rolloff at 100 cycles.

From this information the design of an R-C stage can easily be completed, according to the circuit's requirements. If the desired low-frequency rolloff is 20 cycles, just multiply all capacitor values by 5 and take the next larger stock value. For example, if the cathode bypass capacitor is given as 3.7 μf, a minimum of 18.75 μf, is needed for a 20-cycle rolloff, so a 25-μf capacitor will be adequate.

The maximum available output is based on the clipping point for the operating condition given. No information about distortion is given in these tables.

Another easily obtained manual is published by Sylvania. This costs $2 and includes service. It, too, has a tabulated section for R-C amplifier design, with 22 tables covering 73 tube types. In general, these are the same types as those covered in the RCA manual, but each has some the other misses. Also the information listed differs. The Sylvania tabulation does not give capacitor values but does include information on distortion at two different operating levels, giving gain, volts in and out for each level.

For completeness of tube type coverage, Tung-Sol service is probably best, giving you two large loose-leaf binders for the purpose. They do not include a convenient listing for R-C design like RCA and Sylvania. The Tung-Sol service includes tube types other than those manufactured by them, for the sake of completeness, but even this service does not list every type, although it is probably the most comprehensive manual available in that direction.

For completeness of data on tubes covered, the Brimar application report service seems about the best (available from Standard Telephones & Cables, Valve Dept., Footscray, Kent, England). Unfortunately, in the few years that this service has been operating, they have covered little more than a couple of dozen tube types. The Mullard Data service, also very comprehensive in detail, only covers Mullard tubes and is not readily applicable to American types—especially as Mullard uses their own tube numbering system.

I will not go on and list the merits and demerits of every tube manual available and I hope that no manufacturers will feel slighted because they have not been mentioned. All probably list something that the others miss, although much of the coverage is almost identical. But with all this information, we may still fail to find the data that would be most helpful for a particular job.

Pentode circuits

As an example, I recently had an application for which the tubes listed in the R-C-coupled section were not suitable. A number of channels with an input never exceeding 1 volt required maximum amplification in a single tube with minimum current drain, and the output had to be at an impedance not much lower than 100,000 ohms. A job for a sharp-cutoff pentode. Thumbing through the available types, the 6AG5 looked most likely, but neither of the manuals has it in the R-C section because its usual application is in if or rf circuits.

The available data is listed below:

Plate (volts)	100	125	250
Grid No. 2 (screen)(volts)	100	125	150
Cathode resistor (ohms)	180	100	180
Plate (ma)	4.5	7.2	6.5
Grid No. 2 (ma)	1.4	2.1	2.0
Transconductance (μmhos)	4,500	5,100	5,000
Plate resistance (megohms)	0.6	0.5	0.8
Grid No. 1 (volts for I_b = 10 μa)	−5	−6	−8

This information is found in several manuals. The only difference is that the items are in a different order. Where do we go from here?

The following procedure has been found fairly reliable and produced a good answer to this problem. We have specified that the plate coupling resistor must be 100,000 ohms. For maximum swing, using a B plus of 250 volts, we

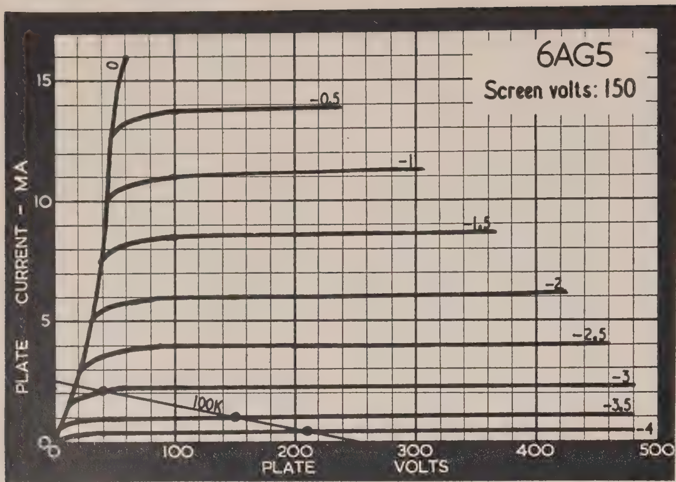


Fig. 1—Characteristic curves of 6AG5.

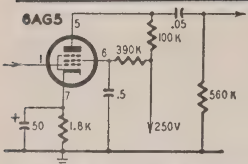
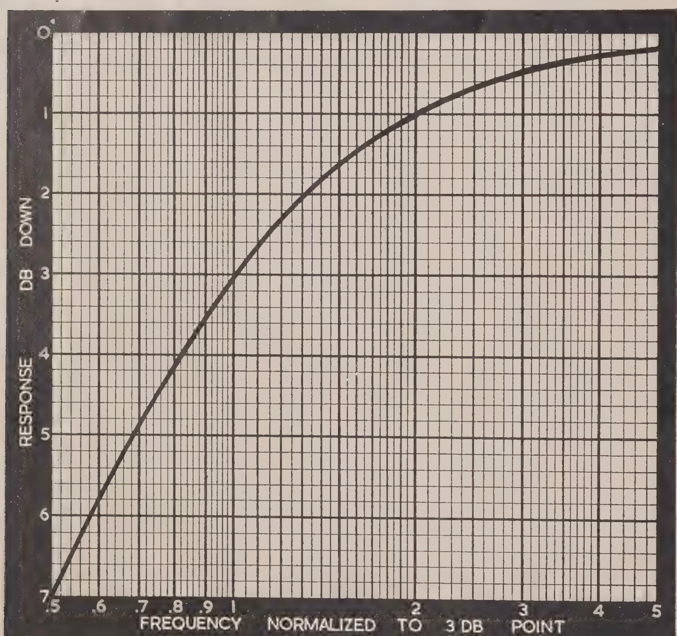


Fig. 2—R-C circuit using a 6AG5 pentode.

Fig. 3—Normalized curve aids in predicting response using various capacitors in circuit.



should have about 150 volts on the plate, or 100 volts drop across the 100,000-ohm resistor, placing the operating point near the center of the available swing. This represents a plate current of 1 ma. In each case the screen current is a little less than one-third the plate current. The screen voltage should be a little lower than the plate voltage to assure stability, so a screen feed resistor more than three times the plate resistor value should be used. A 390,000-ohm unit was tried and found successful. The total cathode current will be about 1.25 ma. Now, we need a cathode resistor to supply about 1.5 volts bias, so the tube will handle 1 volt rms safely. A resistor of 1,200 ohms seems to be needed. Let's see how this compares with the middle column of data, the nearest to this operating condition.

The specified 100-ohm cathode resistor, with a total current of 7.2 + 2.1 = 9.3 ma, will produce a bias of 0.93 volt. If we assume the plate voltage is kept the same and the bias increased to 1.5, it is obvious that the current will get reduced to a little less than two-thirds or between 5 and 6 ma, instead of the 1.25 ma we assumed. So with a 1,200-ohm bias resistor, the current would be more than 1.25 ma, and the plate and screen voltages would be lower than prescribed, probably below 100 volts. We need more bias to handle the plate current and voltage.

Different values were tried, with 1,800 ohms giving the best result. Voltages measured with a vtvm were: grid bias (cathode to ground), 3.5; plate volts, 150; screen, 140. As the tube is operated fairly well into its curvature (approaching the plate bend cutoff) there is an appreciable second harmonic, but it did not matter in this application. We would guess that transconductance at this point is about a third of the quoted value as the plate current is about one-sixth the quoted value. This guess is arrived at by taking an average between the ratio and its square root: 6 is halfway between 3 and its square, 9. We would expect a change in plate current of 6 to 1 to be accompanied with a change of transconductance of 3 to 1, if the screen is changed in the same proportion. This turned out to be a good guess. The stage's gain measured 170, with a 100,000-ohm plate coupling resistor. This means the transconductance is 1,700, just one-third the quoted value of 5,100.

We could have figured this gain from the characteristic curves for the 6AG5, using a 100,000-ohm load line (see Fig. 1). For a 1-volt change in grid potential, from −3 to −4, the plate voltage changes from 40 to 210, representing a gain of 170.

The grid-resistor coupling to the following stage will cut down the gain. The grid resistor had been fixed by previous design figures at 560,000 ohms, so gain will be reduced by the effect of paralleling 560,000 ohms with 100,000 ohms in the plate circuit. As plate resistance is quoted as 500,000 ohms, and is probably much higher than this at the chosen operating point, we can for convenience ignore its effect. Placing 560,000 ohms in parallel with 100,000 ohms gives an ac load resistance of 85,000 ohms. Gain is reduced, $0.85 \times 170 = 145$.

To figure the low-frequency response, which must go down to 20 cycles, first we consider the coupling capacitor, which will introduce a 3-db loss when its reactance is equal to 100,000 ohms and 560,000 ohms in series, 660,000 ohms. A .02-μf capacitor has a reactance of 390,000 ohms at 20 cycles, which will cause a loss of about 2 db.

Next, the cathode capacitor: First thing is to figure out how much the gain will change by not having it at all. With a gain of 145, an 1,800-ohm cathode resistor and a 85,000-ohm load, there will be a gain of $\frac{145 \times 1.8}{85} = 3.1$ in the cathode resistor. This means that the grid-to-ground potential will be 4.1 times the grid-to-cathode potential, or the gain will be reduced by a ratio of 4.1 due to cathode feedback. When the cathode bypass capacitor has a reactance of 1,800 ohms too, there will be 3 db less than this maximum feedback. So there will be approximately 3 db feedback when its reactance is 1,800 divided by 4.1, or about 440 ohms. A 20-μf capacitor has a reactance of 400 ohms at 20 cycles and contributes about 3 db loss in this circuit. Using a 50-μf capacitor will keep its loss less than 0.8 db.

We have to know how much the screen capacitor will affect the gain. Without it, screen voltage will swing about the same as the plate voltage so the tube will have about the same gain as it would triode-connected. Gain of a normal triode is about 35 but, under this biased-back condition, it comes out to be about 15. This is somewhat of a guess at best because we have assumed plate and screen will have equal voltage swings, which may not be quite true. If it is not, we have no data to go on anyway. But if we estimate that the gain will drop 10 times by removing the screen capacitor, we have a fairly good basis for calculation. The feed resistor is 390,000 ohms so, when the screen capacitor's reactance is 390,000 ohms, we will have 3 db short of the maximum feedback (occurs when screen capacitor is removed) in the screen, while a reactance of about $\frac{390{,}000 \text{ ohms}}{10}$, 39,000 ohms will give a feedback of about 3 db. A 0.2-μf capacitor will have a reactance of 39,000 ohms at 20 cycles, so we should use about 0.5 μf to give a loss of about 0.8 db.

If we use a .05-μf coupling capacitor, the loss due to it will be about 0.3 db, so the total loss at 20 cycles is likely to be less than 2 db $(0.8 + 0.8 + 0.3 = 1.9)$ with the circuit of Fig. 2.

Just a minute, someone will be saying, I know that when the reactance is equal to the resistance there is a 3-db loss, but how do you figure the loss for other reactance values? Well, we can use the response curve in Fig. 3 for this. This can be used to show either loss against frequency or loss against relative reactance. At twice the frequency, the reactance of a capacitor is halved and the loss is 1 db. So if we find the reactance is 0.25 of the resistance at 20 cycles, the loss will be the same as shown at 4 times the 3-db frequency, or 0.3 db.

Next month we will continue with a discussion of triode circuits and the problem of providing sufficient swing to drive output tubes. TO BE CONTINUED

TRUE or *FALSE* Quiz for Audiophiles

By HERMAN BURSTEIN

1. If a power amplifier rated at 100 watts produces 12.5 watts for an input of 0.5 volt, it will produce 25 watts for an input of 1 volt.

False—It will produce 50 watts, because power varies with the square of the voltage.

2. It is more important for phonograph turntable to rotate at a steady speed than at an accurate speed.

True because most human ears can tolerate deviations from correct speed—for example, 34 instead of 33⅓ revolutions per minute—of as much as 1%, 2% or even 3% without these deviations being perceptible or annoying. However, extremely small departures from steady rotation (wow and flutter)—well below 0.5%—are perceptible and annoying to most persons.

3. Single-cone speakers are often superior to coaxial and two-way systems in the same price class.

True—Mere division of the audio spectrum between two or more speakers is not sufficient for reproduction that is smooth, low in distortion and adequate in range. There are several single-cone speakers on the market which in these respects outperform multiple speaker systems at comparable total price. On the other hand, the ultimate in audio today is obtained by multiple-speaker systems that use specially designed units for each portion of the audio spectrum.

4. Many AM broadcast stations meet high-fidelity requirements so far as frequency range is concerned.

True—AM stations are not required to cut off above 5,000 cycles, as is often supposed. Many maintain flat response to 12,000 or even 15,000 cycles. However, most AM tuners cut off sharply above 5,000 cycles or thereabouts for design reasons and to minimize interstation whistle. Some high-fidelity AM tuners do maintain response well above 5,000 cycles, but unless the signal is a relatively strong one, noise and adjacent-channel interference may become unpleasant.

5. Since afc (automatic frequency control) increases distortion, it is best to operate an FM tuner with afc off, if this is optional.

False because, if anything, afc decreases distortion. The disadvantages of afc are a slight loss in sensitivity—in most cases much too small to be of importance—and difficulty in separating a weak station from a nearby strong one; that is, with afc on, the tuner tends to capture the strong signal rather than the weak one if the two are close to each other on the dial.

6. The principal difference between professional and home tape recorders operating at 7.5 ips is in their high-frequency response.

False. Many home recorders have high-frequency response extending as far as that of their professional brethren. The principal differences, for the same frequency response, are lower distortion and higher signal-to-noise ratio in the professional machine. Distortion includes that due to rumble and flutter in the transport mechanism.

7. If a high-fidelity system contains a loudness control, then a gain control is superfluous.

False. Maximum setting of a loudness control should correspond to the original level of the music and should provide flat response; as the control is backed down, bass should be augmented relative to the other frequencies. However, signal level will vary according to program source and other factors. Thus it is necessary by means of the gain control to restore the condition at which the maximum loudness control setting corresponds to original level.

8. Sometimes 300-ohm TV ribbon (antenna lead-in) is used to connect a power amplifier to a speaker, often because it is flat and therefore convenient for running beneath a rug. However, since the impedance of the power amplifier and of the speaker is usually in the range of 4 to 16 ohms, it is not advisable to use 300-ohm wire for this purpose.

False—TV ribbon line is perfectly suitable for connecting a power amplifier to a speaker. Because of its low capacitance per foot, it may be more suitable than other kinds of wire where a long run is required — except where low-efficiency speakers and high-wattage amplifiers are used at high levels, as power loss in small-diameter ribbon line may become excessive. Ribbon line may be used as its 300-ohm impedance does not have any effect unless it is terminated in a 300-ohm load.

9. To minimize record wear, the tracking force of a phonograph stylus should be as light as possible consistent with its faithfully following the undulations of the groove. If one does err, it is better to err in the direction of slightly too little rather than slightly too much tracking force.

False because too little tracking force will result in an increase in distortion because the stylus no longer completely follows the groove. Moreover, there will be greater wear than that due to slightly excessive tracking force because the stylus bounces around instead of adhering to the groove. END

deluxe remote baby sitter

Carrier-current system permits baby-listening from within the home or from several houses away

By E. H. KAUFMAN

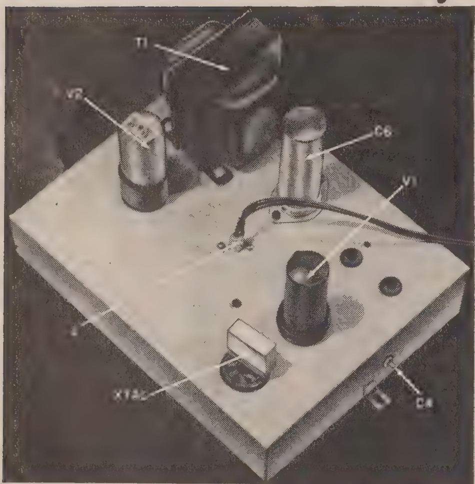
THE problem of how to get out evenings without the added expense of a baby sitter arises in every family with children. Some folks use a member of the family or a neighbor as a sitter; this is not always a happy solution. This article will describe a remote baby-sitting system which permits a neighbor to baby sit for you without leaving her home.

When you visit your nearby neighbors, you will be able to sit back and enjoy the evening without running back and forth to check the children. When possible, a direct line to a neighbor, an audio amplifier, microphone and speaker can't be beat, but in most cases the neighbor who will baby-sit for you is several houses away.

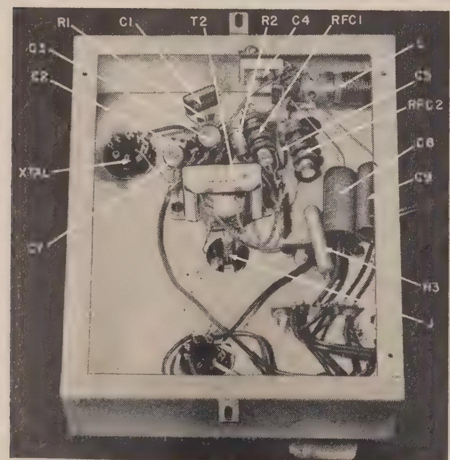
The solution is to use a carrier-current system. Although these systems have been discussed before, I do not consider existing circuits satisfactory for baby sitting. One reason is the possibility of the carrier shifting frequency over a period of several hours, causing a partial or complete loss of the signal at the receiving end. Second, a separate receiving unit must be built.

My circuit circumvents these problems by being crystal-controlled and operating in the broadcast band. It can be tuned in on almost any broadcast receiver.

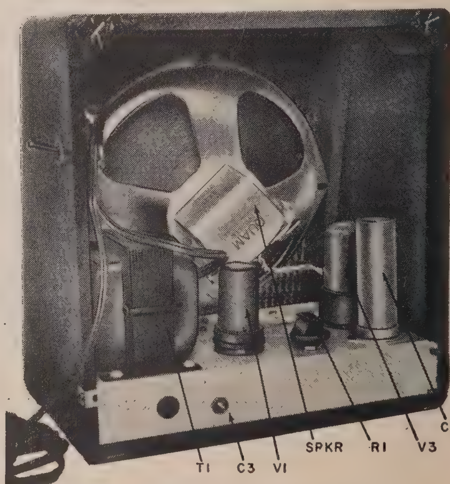
The main defect of a carrier system is that reception is limited to houses on the same common side of the house



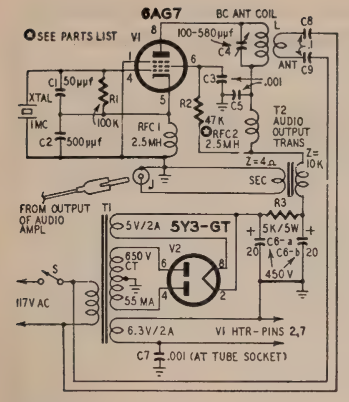
The carrier current transmitter. Note crystal plugged into octal socket.



Parts layout under transmitter chassis.

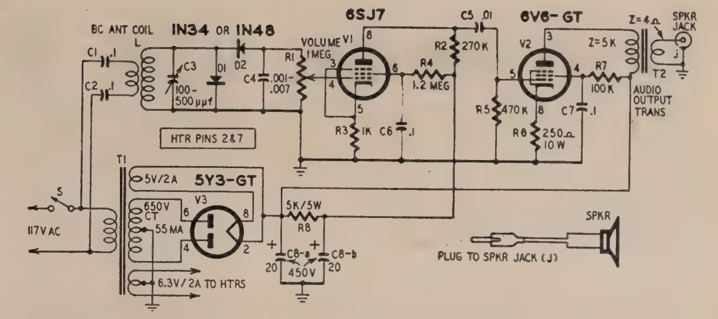


Compact receiver fits into speaker case.



R1—100,000 ohms, ½ watt
R2—47,000 ohms, 2 watts
R3—5,000 ohms, 5 watts
C1—50 μμf, mica
C2—500 μμf, mica
C3, 5, 7—.001 μf, disk ceramic
C4—trimmer, 500 μμf (see text)
C6—20-20 μf, 450 volts, electrolytic
C8, 9—0.1 μf, 600 volts
J—phono jack
RFC1, 2—2.5 mh, 200 ma, pie-wound, rf choke (Miller 4537 or equivalent). If transmitter is operated below 1 mc, use a higher value (5 mh) for RFC2, to prevent self-oscillation.
L—antenna coil, 540–1,700 kc (Miller 43-A or equivalent)
S—spst, toggle
T1—power transformer; primary, 117 volts; secondary, 650 volts ct, 55 ma; 5 volts, 2 amps; 6.3 volts, 2 amps (Stancor PC8407 or equivalent)
T2—output transformer; primary, 10,000 ohms; secondary, 4 ohms (Stancor A3879 or equivalent)
V1—6AG7
V2—5Y3-GT
Crystal, 1 mc
Chassis, 7 x 9 x 2 inches
Sockets, octal (3)
Miscellaneous hardware

Fig. 1—Circuit of the crystal-controlled carrier-current transmitter.



R1—pot, 1 megohm
R2—270,000 ohms, 1 watt
R3—1,000 ohms, 2 watts
R4—1.2 megohms, 1 watt
R5—470,000 ohms, ½ watt
R6—250 ohms, 10 watts
R7—100,000 ohms, 2 watts
R8—5,000 ohms, 5 watts
C1, 2, 6, 7,—0.1 μf, 600 volts
C3—trimmer, 500 μμf (Arco 304M or equivalent)
C4—between .001 and .007 μf (see text)
C5—.01 μf, 600 volts
C8—20-20 μf, 450 volts, electrolytic
D1, 2—1N48, 1N34
J—phono jack
L—antenna coil, 540–1,700 kc (Miller 43-A or equivalent)
S—spst, toggle
T1—power transformer; primary, 117 volts; secondary 650 volts ct, 55 ma; 5 volts, 2 amps; 6.3 volts, 2 amps (Stancor PC8407 or equivalent)
T2—output transformer; primary, 5,000 ohms; secondary, 4 ohms; 5 watts (Stancor A3877 or equivalent)
V1—6SJ7
V2—6V6-GT
V3—5Y3-GT
Chassis, 7 x 9 x 2 inches
Phono plug
Sockets, octal (3)
Speaker, PM
Miscellaneous hardware

Fig. 2—Three-tube no-drift receiver to be used with carrier system.

supply transformer. In many areas, however, the same transformer will supply at least a block of houses.

The transmitter circuit (Fig. 1) is a modified Pierce-Colpitts. It is not dependent on the electrode capacitance of the tube because two mica capacitors are connected across the crystal in parallel with the tube's grid–cathode and plate–cathode capacitances. Feedback is a function of the relative capacitance of the two micas and may have to be varied if the operating frequency of the circuit is radically changed from 1 mc.

A 1-mc crystal can be obtained from surplus sources for about $4. New transmitting crystals can be obtained from electronic supply houses for $4 to $18. A 1-mc crystal avoids a direct radio-station frequency (Only four stations in North America operate on this frequency.—*Editor*) and is easily obtained.

Crystals with a pin size of .093 inch and ½-inch spacing will fit a standard octal socket. The circuit is straightforward and troublefree. About 1–2 watts of audio power is required to modulate the transmitter. Any audio amplifier will do the job. A radio with a phonograph jack can be used by plugging in a crystal mike, provided its gain is sufficient.

The best way of mounting L, a J. W. Miller type 43-A antenna coil, is to cut off the mounting lug and solder the coil directly to the lugs on the trimmer capacitor. To determine proper trimmer adjustment, place a dc voltmeter across the 5,000-ohm resistor R3. About 100 volts will be indicated. Screw the trimmer in and out; a broad point will be found where the voltage falls to below 50. The circuit is now properly loaded. Plug in a radio and turn to 1,000 on the dial (allow 15 minutes warmup time for stability). The system is now in operation.

Optional receiver

For those who would rather not use a radio as part of their system a carrier-current receiver circuit is shown in Fig. 2. The three-tube circuit eliminates receiver drift and provides considerable gain. More gain can be obtained by adding a 10-μf 25-volt electrolytic capacitor across the 6SJ7 cathode resistor R3. Removing or decreasing the value of C4, the tone control capacitor, will also increase gain.

Observe proper polarity with the germanium diodes. The bypass diode increases amplifier gain and decreases noise and hash to a large extent.

The receiver's frequency range is about 430–1,700 kc. To receive frequencies below 430 kc add a 50–100-μμf capacitor across C3. If the receiver will not tune to a high enough frequency, replace C3 with a trimmer of lower capacitance.

The transmitter will operate satisfactorily at 530–540 kc if trimmer C4 is changed to an Arco 304M (320 μμf) and a 100-μμf mica is wired across it.

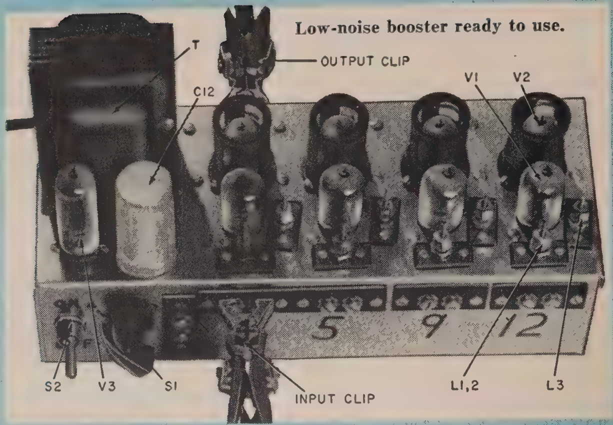
The receiver is very quiet without any appreciable 60-cycle hum. Compared to some broadcast receivers it seems to have better quality with excellent music reproduction. END

"Fine! Now a little more bass from the 15-incher in the corner!"

LOW-NOISE TV BOOSTER

This 4-channel unit brings in that color program. Helps to end weak color and confetti

By J. R. LANGE, K9ARA



Low-noise booster ready to use.

THE growing use of color TV sets has created new interest in improving fringe area reception. The fringe for good color reception seems to be closer to the TV transmitter than for black and white. We recently purchased a color TV set before local uhf stations were equipped to originate or relay color programs. Nearly snow-free black-and-white reception was obtained from Milwaukee and Chicago vhf channels 4 and 5 but very little color and lots of confetti was present during color broadcasts. Little could be done to the antenna so several boosters were tried using 6J6 and 6BZ7 tubes. Some improvement, but not enough to be really significant, was obtained on channel 5 using a hot 6BZ7.

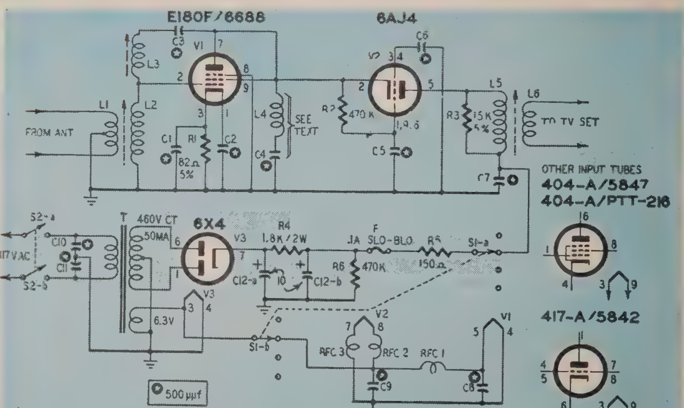
The noise figure or snow contribution of a booster or TV tuner rf stage is mainly determined by the tubes. The higher the tubes' transconductance, the lower the noise figure. Common tubes, such as the 6J6, 6BK7-A, 6BQ7-A, 6BZ7, 6BZ8, etc., now used for TV tuners, boosters and distribution amplifiers, have transconductances of 6,000 to 9,000 μmhos. Some miniature tubes such as the 6AJ4, 6AM4 and 6BC4 are rated at about 10,000 μmhos. Since the first or grounded cathode stage of a vhf cascode rf stage contributes most to the noise figure, a more expensive ($8 to $15) tube can be used for the first stage and a less expensive one for the grounded-grid stage.

I built a channel-5 cascode TV booster with a Western Electric WE 417-A/5842 followed by a G-E type 6AJ4. The 417-A has been popular with amateurs on the vhf bands and has a low noise figure because of its 20,000–25,000-μmho transconductance. The color picture improvement was surprising. Color confetti was reduced. Color sync and saturation were improved. The booster also improved all black-and-white sets it was tried with.

The requirements of wide-band microwave if and video amplifiers have led to the development of high-performance pentodes such as the WE 404-A/-5847 and Amperex and Mullard E180F-/6688. They feature a close-spaced grid and cathode structure similar to that of the 417-A. When triode-connected, with screen tied to plate, a grounded-cathode stage with a transconductance of 20,000 μmhos can be obtained. Noise figures are nearly as low as with the 417-A.

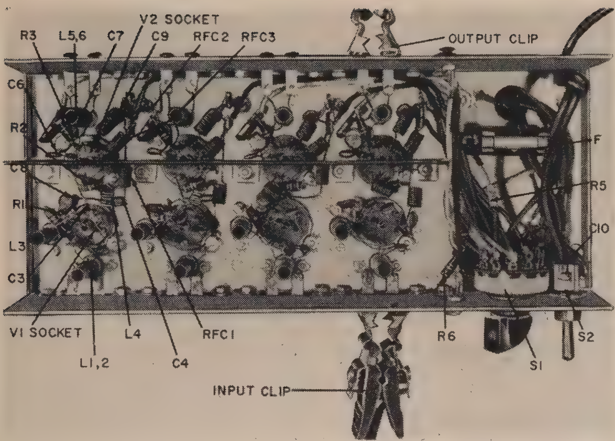
Our four-channel vhf booster was built with triode-connected 404-A's and E180-F's in the input stages of channels 4, 5, 9 and 12, and 6AJ4's in the grounded-grid stages using a series dc cascode circuit. The 6AJ4 is a good grounded-grid amplifier and has a heater-to-cathode voltage rating sufficient for use in the series dc or direct-coupled cascode circuits. It is moderately priced and can handle the plate current required for proper operation of the first stage. The presence of the suppressor grid in a pentode input tube causes little increase in noise, but does cause some loss of gain when the 404-A is used on channels 7 to 13. This is probably due to the internal connection of the suppressor to cathode and the common-cathode lead inductance. The E180F suppressor can be separately grounded and the two cathode leads doubly bypassed to give better high-band gain.

If a booster is to be constructed, decide what input tube type is to be used and what form the booster will take



*R1—82 ohms, 5%
*R2—470,000 ohms
*R3—15,000 ohms, 5%
R4—1,800 ohms, 2 watts, 10%
R5—150 ohms
R6—470,000 ohms
All resistors ½ watt unless noted
*C1—9—500 μμf, disc ceramic
C10, 11—500 μμf, disc ceramic
C12—10–10 μf, 450 volts, electrolytic
F—1/10-amp slow-blow fuse
*L1—6—see coil-winding data table
*RFC 1, 2, 3—15 turns No. 24 enameled wire on 3/16-inch-diameter air core (see text)
S1—3-pole 4-position nonshorting rotary switch (1 circuit not used) (Mallory 3234J or equivalent)
S2—dpst toggle
T—Power transformer: primary, 117 volts; secondary, 460-volt ct at 50 ma, 6.3 volts at 2.5 amp (Stancor PC-8418 or equivalent)
*V1—E180F/6688 (Amperex or Mullard), 404-A/5847, 404-A/PTT-216 or 417-A/5842 (WE or Ericsson)
*V2—6AJ4 (G-E, Raytheon or Tung-Sol)
V3—6X4
*Terminal strips, 2-connection (2)
Terminal strips, 2-connection (2)
Chassis, 10 x 4 x 2½-inch aluminum box
*Shield for V2, heat conducting, IERC Military type B or equivalent (1)
Line cord
Miscellaneous hardware
**Indicates components for one channel of the booster. A 4-channel booster needs 4 of each part marked with an asterisk. Power supply provides current for all booster channels.*

Fig. 1—Circuit of one amplifier channel and power supply.



Bottom view showing parts layout of one channel and power supply.

for best utility and appearance. For high-band channels the 417-A, E180F, and 404-A (in the order named) are best for gain. The gain with the 404-A is still high enough so that noise figures of all three tubes are comparable and around 4.5 db. Low-band gains are nearly the same, and noise figures of about 3 db can be obtained. These tubes are usually not sold locally but are obtainable from several mail-order surplus dealers. Make sure tubes are new; not used or rebranded. E180F's are obtainable from Amperex Electronic Corp., Hicksville, N.Y., and from Amperex or Mullard distributors. The 404-A and 417-A/5842 are also obtainable from Ericsson (State Labs, 649 Broadway, New York, N.Y.) at list prices. Special-purpose tubes may often be ordered from dealers who do not list them in their catalogs. Be sure to specify the 417-A/5842 completely to avoid getting a WL417-A surplus klystron.

Building the unit

The booster shown in the photographs was built for use on top of or alongside the TV set. It was built into a 2½ x 10 x 4-inch Channel Lock aluminum box and has a self-contained power supply. Fig. 1 shows the circuit for a single channel. Four of these are combined to form a four-channel booster. The power supply is as in Fig. 1. Plate and heater power can be switched to any of the four peaked single-channel amplifiers. Input and output leads are quickly connected using clothespin type antenna clips. A straight-through connection is provided for local vhf or uhf converter output.

The inside view of the booster (see photos) shows the suggested circuit layout. Sockets are oriented with plate leads toward the output. A sheet-aluminum shield is placed across the 6AJ4 socket (passing between pins 3 and 4 and 8 and 9) to prevent oscillation. Lead lengths of the input tube cathode bypass and the 6AJ4 grid bypass capacitors should be as short and direct to a chassis ground as possible. The input and neutralizing coils are insulated from the chassis.

The tubes should be shielded from each other to keep the grounded-grid stage stable. The ordinary JAN type shield causes high bulb temperatures and for longest tube life should be avoided. The four-channel amplifier has heat-conducting shields on the 6AJ4's. (We used IERC military B type shields made by IERC, 145 Magnolia Boulevard, Burbank, Calif.) It is recommended that they be used on both tubes.

Besides the input tube the input coil has an important effect on the booster's noise figure. The coil-winding data table gives coils that are overcoupled past the point of maximum gain so as to present to the tube the impedance giving lowest noise figure. The four-channel booster uses ¼-inch-diameter coil forms from a microwave or radar if strip. Commercial ¼-inch-diameter forms such as the Cambridge Thermionic Corp. LS-6 or the James Millen 69048 are equivalent. High-frequency powdered-iron cores coded white should be used. Lower-frequency cores will lower the coil Q and may increase the noise figure.

The low-band input, neutralizing and output coils are wound tightly with No. 28 enameled wire. Adhesive tape cut into ⅛-inch strips will help to hold the ends while winding. Bend the first inch of wire at a right angle to the direction of winding and lay on the form parallel to the axis. Wrap a small length of tape several times around the form and the lead near the bend. Wind the coil, keeping the turns tight. After the last turn, bend the wire at right angles to the windings and parallel to the axis of the form. Tape down like the starting end. Leave 1-inch leads. Coat the winding and tape with a good coil dope such as Q Max or polystyrene cement. Model-airplane type cements should not be used. They reduce coil Q.

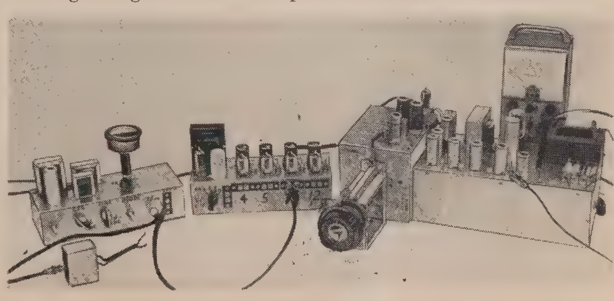
The input coil and output windings L1 and L6 are similarly tightly wound, in a reverse direction, over the grid and plate windings after they are dry. When halfway through the input winding, scrape 2 inches of the wire bare, fold over, twist and tin with solder so that a 1-inch twisted lead for the center tap sticks out. Finish winding, tape the end and apply another coat of coil cement. Check with an ohmmeter to make sure the two windings are not shorted.

Coils for channels 7 to 13 are wound with No. 24 enameled wire. This is easily done after the forms are mounted on the chassis. The heater and interstage rf chokes are tightly wound over a 3/16-inch-diameter rod or drill shank. By scraping the enamel off, tinning with solder and bending the leads before sliding out the rod, the choke will not be distorted when ready to solder in the circuit. The interstage choke for channels 7 to 13 is wound using the leads of capacitor C4, spreading turns apart one turn width.

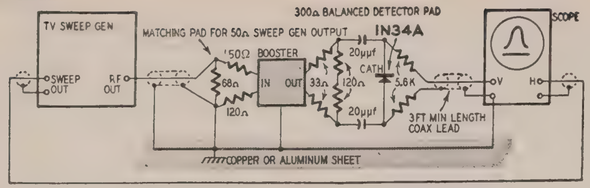
If space is a problem or if a booster for only one channel is needed it can be built into a 2 x 2 x 4-inch aluminum box with power taken from the TV set. It could then be easily concealed. An antenna-top version can be enclosed in a 3 x 4 x 5-inch weatherproof box and power can be sent up externally. The bandwidth of a single-channel unit can be widened to cover channels 7 to 13, or several low-band channels such as 2, 3, 4 or 4 and 5. A sweep generator and oscilloscope should be used to check alignment. Single-channel boosters can be peaked using a TV set and station signal if the coil winding data given for the desired channel is followed.

Booster alignment

The booster's tuning can be checked best by using a sweep generator, oscilloscope and 300-ohm balanced detector



Booster's channel-9 circuit undergoing a noise test.



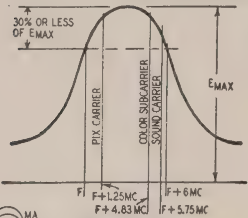


Fig. 2 (above, left)—Alignment setup and curve for tuning the booster's channels.

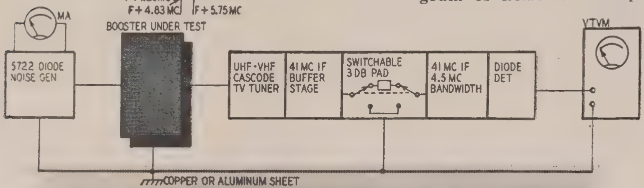


Fig. 3 (below)—Block diagram of noise-test setup.

NOISE-FIGURE COMPARISONS

TV Channel	4	5	9	12
Uhf-Vhf Cascode TV Tuner Alone	5.3 db	5.1 db	7 db	7 db
Commercial Push-Pull 6J6 Tunable Booster	5.3 db	5.5 db	6.5 db	6.4 db
Commercial Single-Channel 6BZ7 Cascode Booster	—	4.4 db	—	—
404-A, E180-F, 6AJ4 Cascode Booster	2.7 db	3 db	4.3 db	4.8 db
417-A, 6AJ4 Cascode Booster	—	2.9 db	—	—

pad as shown in Fig. 2. The input circuit response can be checked by disconnecting L5 from the plate of the 6AJ4 and shunting the 15,000-ohm output damping resistor with a 150-ohm resistor. Touch a rf crystal demodulator probe, connected to the scope, to the plate of the 6AJ4 and observe a single peaked curve. This curve should be centered, using the input and neutralizing coils, on the desired TV channel. The number of coil turns may have to be changed if the response cannot be centered. In some instances the overall response curve may be too narrow or the TV tuner may reflect an impedance higher than 300 ohms to the booster. When the booster is connected to the TV set then, the bandwidth is actually narrower than the observed response and may be contributing to instability. In this case, bandwidth can be widened by increasing the number of turns on L6 or reducing the 15,000-ohm plate damping resistance.

Bandwidth can be widened to give a flat response over several TV channels on either side of a single channel picked according to coil-winding data. This requires that the input and output windings L1 and L6 be wound below and separated 1/32 to ⅛ inch from the grid and plate windings L2 and L5; and 3 to 30-$\mu\mu$f trimmer capacitors are placed across L1 and L6. The input response is first adjusted and then the overall response. In adjusting the double tuned coils, the coil spacing will mainly determine the bandwidth, the capacitor will tilt the curve and the core is used to maximize the curve amplitude in general. There is some interaction.

Data on the noise figure of the four-channel and other boosters measured over a 4.5-mc if bandwidth is shown in Fig. 3 along with the test hookup. A 1-db reduction in noise figure gives a noticeable reduction of snow. A 2–3-db reduction in noise figure, possible with this type of booster in front of the average cascode tuner, gives a snow reduction equivalent to stacking the receiving antenna or doubling the TV transmitter power.

When the booster is complete, final adjustments can be made using the TV signal and TV set. Pick a time when the signal is weak, but not fading, and external interference is at a minimum. Connect the booster between the antenna and TV set and make sure the input leads, output leads and power cord are separated from each other. Use as short a lead as possible between the booster and TV tuner. After the booster has warmed up, adjust the output coil for maximum picture contrast and the input and neutralizing coils for least picture snow. Note the snow content of dark picture areas while tuning the booster. In some cases, particularly on channels 7 to 13, wrapping a 4-inch square of aluminum foil around the input lead and sliding it along 1 to 4 feet from the booster will improve the picture. Readjust or remove for other channels.

If the booster oscillates (indicated by a white or torn raster on the TV screen), turn off the booster, retune the neutralizing coil until no oscillation occurs when the booster is turned on and warms up again. Because of the high gain of this booster, oscillation may be present when it is mounted near the antenna and radiation from the long output lead is picked up by the antenna. In this case 300-ohm shielded line should be used between the booster and TV set. If a 75- to 300-ohm transformer is connected near the TV set, coaxial line can be used. For coupling to a 75-ohm coaxial line, the number of turns on L6 should be half the number given by the winding data, and one end is grounded.

If the booster gives little or no picture improvement, check all operating voltages. The plate current should be at least 20 ma with a 404-A or 417-A input tube and 16 ma with a E180F. Currents much higher than 20 ma will shorten the life of the 6AJ4. Also disconnect the input-winding center tap from ground and check for a short between L1 and L2.

Switching inputs and outputs in addition to plate and filament power is possible as long as the input and output leads and switch contacts are physically separated. A three-gang six-pole non-shorting two-or-more-position steatite insulated rotary switch would be satisfactory. (These switches are made by Mallory and Centralab.) The middle gang can be used for plate and heater switching and to separate the input and output gangs. This kind of switch takes up a lot of room and will leave room for three channels only. END

Coil-Winding Data Table

TV Channels	L1 Turns	L1 Wire*	L2 Turns	L2 Wire*	L3 Turns	L3 Wire*	L4 Turns	L4 Wire*	L5 Turns	L5 Wire*	L6 Turns	L6 Wire*
2	7½	No. 28	11	No. 28	21	No. 28	20	No. 24	14	No. 28	6	No. 28
3, 4	6½	No. 28	9	No. 28	17	No. 28	16	No. 24	12	No. 28	4½	No. 28
5, 6	4½	No. 28	6	No. 28	13	No. 28	12	No. 24	9	No. 28	3½	No. 28
7, 8	3½	No. 24	3	No. 24	4½	No. 24	4½	Use C4 leads	4½	No. 24	3	No. 24
9, 10	3	No. 24	2½	No. 24	4	No. 24	4½	Use C4 leads	4	No. 24	2½	No. 24
11, 12, 13	2½	No. 24	2	No. 24	3½	No. 24	4½	Use C4 leads	3½	No. 24	2½	No. 24

*All coils use enameled wire except coil L4, channels 7–13, which uses the leads of C4.
1. L2, L3 and L5 are tightly wound on ¼-inch-diameter slug-tuned coil forms such as James Millen 69048-B with No. 19 mix core (coded white) or Cambridge Thermionic Corp. LS-6 with 20063-D core (coded white).
2. L1, center-tapped, and L6 are reverse-wound tightly over L2 and L5, respectively.
3. L4 is 3/16-inch-diameter air-core, tightly wound choke on channels 2 to 6 and is wound 3/16-inch diameter, with leads of C4 spaced 1 turn, on channels 7 to 13.

tv dx

By ROBERT B. COOPER, Jr.

BY now, almost everyone has read or heard something about the International Geophysical Year (IGY). The IGY is an 18-month period during which 65 nations will study the actions of the earth and solar system. This period is being used to gather facts more than to study the earth—huge storehouses of facts which scientists will be able to study for generations to come.

One of the fact-gathering programs (there are 11 in all) now being investigated—is concerned with the ionosphere and—to be more specific—the effects of the ionosphere on vhf and uhf radio–television signals entering it. At present, amateur radio observations are being used in this study and a plan is underway to include TV dx reports in the program. This is where you come into the picture.

The ionosphere study group is looking for consistent, monthly reports on any forms of unusual TV reception that might be linked to the ionosphere. If you feel that you might fit into this proposed program, drop me a line outlining your general dxing habits (time of day spent dxing, greatest reliable range, experience and a fairly complete description of your equipment). If enough interest is mustered for this project, I will attempt to carry the ball from here.

Why IGY now?

The IGY period began on July 1, 1957. This date was not picked on a haphazard guess, nor was it a matter of international politics. The predicted peak of the 11-year sunspot cycle, expected to fall within the 18-month IGY period, was the determining factor. Past experience has shown that definite correlations exist between high sunspot numbers and various effects here on earth—such as radio propagation, aurora and possibly weather conditions. To sum up, we can expect more in the way of excellent and unusual dx conditions during the IGY, than in any similar recent period.

The summer was unusual

In our spring TV dx columns, we discussed aurora skip, not so much as a means of logging new stations, but more as a means of noting the effects of one of nature's biggest mysteries on the TV channels.

Aurora, concentrating as it does near the magnetic north (and south) pole, is usually limited to areas along the Great Lakes and into New England. Not being a true north–south phenomenon (due to the location of the magnetic poles), we find locations such as San Francisco, Calif., and Miami, Fla., about the same distance from the auroral center.

You might imagine how unusual it would be to see aurora from Miami. But it happens or at least should have happened on the evening of Sept. 4, when I noted auroral reception on channels 2, 3, 5 and 6 from Fresno, Calif. Reception peaked to the northeast and consisted of the usual hazy, floating lines, not seeming to be either vertical or horizontal in component. No identification was possible on any of the channels.

Ground wave runs wild

September is the traditional month for long-haul trops (ground wave) reception, but various periods in July did their best to erase traditions. Along the Great Lakes, down the Mississippi and throughout the western Gulf, ground wave overstepped its boundaries with every change of weather.

The best dates would seem to have been July 3–8, and July 15–19. Of the more outstanding work done, Dave Janowiak of Milwaukee, Wis., managed to log 59 stations in a single 24-hour period! And all of this via trops, no skip involved.

Paul Swartz and Carlton Howington, central Ohio dx'ers, found ground wave open to 690 miles for high-band loggings on July 3, 17 and 18.

Uhf dx-pert, Carl Lupton of Shelbyville, Ill., noted trops to 780 miles on July 8, with high-band Texas Gulf stations rolling through. But the corker came on July 16–17, with 18 uhf stations seen.

Along the Gulf coast, dx'er Ray Escoffier, New Orleans, and Ed Bourgeois, Norco, La., report frequent trops openings to the West Texas high-band stations (800 miles) and north to the Great Lakes.

The nation's top TV dx'er, Bob Seybold, of Dunkirk, N. Y., took advantage of conditions to push his station total to 310 stations in 5 years of watching. Some of his outstanding results read as follows: July 18, trops to 500 miles, on both vhf and uhf, with 16 uhf stations logged. July 19, the best uhf conditions Bob has ever witnessed. 510 miles the farthest, and stations logged on 18 uhf channels (20 stations in all), 18 of which were over 125 miles distant!

Predicting TV dx conditions on a general basis can be a problem, and even a little risky. It's not too often that we are 100% accurate.

But, TV'er John Broomall, Due West, S. C., read of our Perseids meteor shower prediction in the July column. Noting that it would peak at 0200, Aug. 12, John decided to have a go at this burst reception stuff. The result? His 60th TV dx station, KRLD, logged at precisely 0200, Aug. 12, on a nice long burst. Anyone curious about the weather this Christmas?

Predictions

For the period of Nov. 1–Jan. 1, E-skip reception should follow closely on the heels of magnetic storms (and the resulting aurora). Watch your northern skies for that eerie glow, signifying northern lights, and watch your newspaper for news of strong magnetic storms. E-skip openings will be most frequent south of a line drawn between San Francisco, Calif., and Norfolk, Va. Gulf Coast dx'ers should notice a major upswing in openings to Mexico City and Guatemala, beginning about Nov. 1. All Es openings will be most likely to occur between 1500 and 2000 local time.

F2 layer reception will probably be limited to dx'ers with some type of converter or adapter which enables them to receive TV broadcasts between 40 and 55 mc, originating from Europe. Skip is not too likely to get as high as our American channels, except for brief instances on peak days.

Trops reception will already have tapered off considerably from summertime levels and in general will be weak and spotty in nature for the next four months. Areas along the Gulf and Great Lakes will have the best trops results.

Meteor showers are fairly frequent throughout November and December. One major shower (the Geminids) occurs Dec. 10–14, with outstanding results coming from 1900 to 0200, local time. The Taurids, a minor shower, occurs Nov. 3–10 and promises good early-morning reception. Other showers are the Leonids, Nov. 16–17, and Ursids, Dec. 22. For further meteor-shower information, I suggest you consult your local library for a current copy of *Sky and Telescope*, in which monthly information about showers is given.

Report forms

Free. That's right, free. Sharp bi-color TV Dx report forms, made especially for reporters to the RADIO-ELECTRONICS TV Dx Column. Be the first in your group to have a set. Just send your name and address to TV Dx Column, 154 West 14 St., New York 11, N. Y. END

TV Service CLINIC

conducted by

ROBERT G. MIDDLETON

THE color bar generator is about as basic an instrument on the modern service bench as a vom or vtvm. A color bar generator is something like an automobile—after a certain amount of mileage, we had better have a tune-up if we expect it to serve us as expected.

There are several kinds of color bar generators and, of course, service and maintenance procedure differs for the various types of instruments.

Generator types

First of all, we must recognize the difference between a color bar generator, which provides true colors, as distinguished from a color-difference bar generator, which provides simulated colors.

We must also recognize the difference between a color-difference bar generator and a continuous-running subcarrier generator. If you connect the output from a simple rainbow generator to a wide-band scope, a sine-wave pattern is obtained, as shown in Fig. 1. We often refer to this signal output as a continuous subcarrier, but it is really a continuous *offset* subcarrier—its frequency is (or should be) 3.564795 mc, which is one horizontal-scan interval less than the color subcarrier frequency of 3.579545 mc.

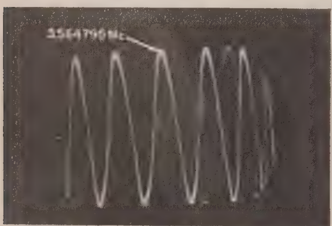


Fig. 1—The output of an unkeyed rainbow generator, seen on the screen of a wide-band scope.

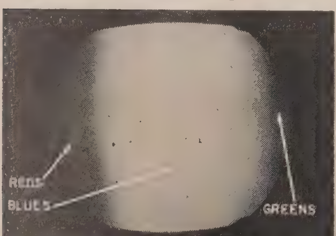


Fig. 2—Unkeyed rainbow pattern, locked in color sync on the screen of a color picture tube.

Such generators are usually crystal-controlled, with a small trimmer capacitor shunted across the crystal to obtain the exact operating frequency. When the crystal is operating on frequency, we obtain a rainbow pattern on the screen of a color picture tube, as shown in Fig. 2. When the crystal is operating far off frequency, we obtain color sync breakup, as shown in Fig. 3.

The easiest and most straightforward way of checking the frequency of the crystal oscillator is with a good heterodyne frequency meter. If you operate this type of generator slightly off frequency, the pattern will not break color sync in a normally operating receiver, but a pull occurs, which causes the pattern to shift horizontally on the screen of the color picture tube, thus giving incorrect information.

The more elaborate form of color-difference signal is keyed into discrete bursts and horizontal sync pulses are provided. Frequency requirements are either 3.564795 mc, or 3.579545 mc, depending upon whether the generator is designed to operate at the true subcarrier frequency or at sidelock frequency. Fig. 4 shows the waveform from a generator of the first type and also illustrates a further service requirement: the peak-to-peak voltage of the sync pulse should be equal to the peak-to-peak voltage of the burst. Service controls are provided for this purpose and a wide-band scope is the most practical indicator to utilize in this regard.

The peak-to-peak voltage of the chroma bar is usually made equal to the peak-to-peak voltage of the burst, although some generators run the chroma bar voltage at a somewhat higher level. A service control is provided.

Space does not permit further coverage of service and maintenance procedures for color bar generators in this installment, but we will discuss more practical pointers another time.

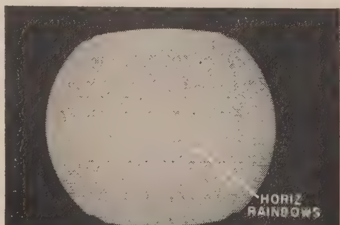


Fig. 3—Appearance of a rainbow pattern which is out of color sync.

Horizontal pull

On a Philco deflection chassis No. D-201, there is a pull horizontally at the bottom of the picture, which appears to be a vertical height trouble until a test pattern is displayed. Then it seems to be a horizontal linearity problem. I have checked everything associated with the vertical and horizontal circuits except the horizontal output transformer.—M. T. S., Longview, Tex.

This report sounds suspiciously like electrolytic-capacitor trouble. We would suggest that you check the electrolytic associated with the sweep and sync for capacitance value and power factor. Replace any of these electrolytics that fall below standard, and it is probable that the trouble will clear up.

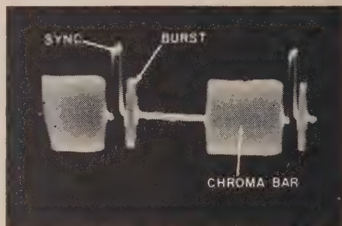


Fig. 4—Accurate reproduction of this color TV waveform requires the vertical amplifier to have the same response at the color burst frequency as it has at the horizontal sync frequency.

Poor fine detail

I have a Magnavox 27-inch receiver, chassis CT-358BA. I don't obtain fine detail and on certain channels whenever there is a vertical line in the picture, such as a door frame, it looks ragged. I realigned the set but still don't obtain fine detail.—A. K., River Edge, N. J.

We would suggest that part of this trouble may be due to poor alignment, there is also a definite possibility of overloading and clipping in the sync signal, with possible entry of video camera signal into the sync channel.

Before realigning the receiver, I would suggest that you check the coupling capacitors in the if and video amplifiers for leakage. Also check the coupling capacitors in the sync channel. Replace any capacitors that show even a small amount of leakage.

This will probably serve to make the picture straight and, if the detail is still poor, a careful check of the alignment would be justified. Start with the tuner and follow through with the if ampli-

fier. Then, check the combined rf–if response curves on the various channels to make sure that you don't have a mixer-regeneration problem on your hands.

Finally (and this is very important), sweep the video amplifier and make sure that you are getting full 4-mc bandpass through the video amplifier circuits.

Vertical roll

I have been troubled by what appears to be a heater–cathode short in one of the tubes of an Admiral 24E1 chassis. A bright horizontal line appears across the upper third of the raster, accompanied by a vertical roll that can't be locked. The vertical hold control cannot be turned to make the picture roll down, only upward. The capacitor marked C1 on the schematic showed signs of leaking electrolyte, but all sections check OK on a capacitor checker.—K. K. M., Germany

This trouble is evidently one of those capacitor failures that doesn't show up on routine checks. Substitution tests are advisable in a situation of this kind. You should start by replacing the multiple-section electrolytic that you mention, because there is possible leakage between sections, which would not be caught on a test of the individual sections.

As we all realize very well, the capacitor that looks the worst is usually not the culprit. So, if replacing the obvious unit does not do the trick, try substituting the other multiple units.

Horizontal curve

I have had several service calls on a Philco 22D4162. This set has a very bad S-shaped weave. I have replaced the sync separator 6CS6, horizontal afc 6AL5 and horizontal multivibrator 12AU7-A. Replacement cleared up the trouble for a while. The curve in the raster appears after the receiver has been operating for some time. All the dc voltages have checked out correctly. The trouble cannot be cured by adjustment of the horizontal hold and horizontal oscillator controls.—C. F. J., New York, N. Y.

This trouble could be due to heater–cathode leakage in the 6AM8 video detector. You do not mention whether the S-shaped weave is a 60- or 120-cycle pattern. This could be a good guidepost in weeding out possibilities.

I suggest that you first make sure that you have no tubes with heater–cathode leakage in the signal circuit. Then, if tube replacement does not clear up this trouble, go to work on the electrolytic capacitors. Check for low capacitance values, poor power factor and leakage between sections.

Intermittent sync

I am working on two TV receivers that are giving me a lot of trouble. They appear to have about the same kind of trouble. They operate OK for several days and then go out of sync. One is a Westinghouse V2243-1 and the other is a G-E model 14007.

The G-E will start with fuzzy edges like piecrust, but with smaller dips and then it will flip and display horizontal bars or three or four pictures horizontally.

When the Westinghouse chassis is acting up, it tears in different spots of the raster and occasionally goes out of horizontal sync.—F. P., Westfield, Mass.

Again, this report is typical of the difficulties which occur when common electrolytic bypass or decoupling capacitors have become marginal. It is most likely that one or more of the electrolytic capacitors associated with the horizontal sync section have lost a substantial fraction of their original capacitance and have developed a low power factor. Also, do not overlook the possibility of leakage between sections of a multiple electrolytic.

Electrolytic capacitors have different characteristics when hot than when cold and their characteristics change after a period of operation as compared with their condition after a nonworking period. Any tests should be made after the receivers have been in operation for several hours.

Vertical rolling

I received a G-E 21C200 chassis with a case of picture rolling. The picture rolls slowly up or down until the vertical-hold control is adjusted. Then, in a few minutes, the picture will start to roll again. The owner informed me that the trouble started after they had a new picture tube installed. All dc voltages seem correct, allowing for the high line voltage which we have here.—W. R. M., Newtön, N. J.

It is evident, of course, that the vertical oscillator is changing frequency in a high or a low direction from time to time. However, because the picture rolls up, it also is evident that the vertical oscillator is not being locked in sync at times. This lack of vertical-sync lock is probably the root of the trouble.

The circuit arrangement of this receiver is such that the condition of the picture tube could affect sync action. I suggest that you first eliminate this possibility by checking with a test pix tube. If this clears up the trouble, a fault is indicated in the picture tube in spite of the fact that it is quite new.

But if this does not correct the vertical sync hold, as is likely to be the case, you will have to dig deeper for the trouble. There is a certainty that you will find little or no vertical sync pulse at the output of the integrator plate (junction of R302 and C302). So, the problem is going to be to find out why this pulse is not present (during the time the picture rolls up). In making this type of test, do not confuse the vertical sync pulse with the kickback pulse from the vertical oscillator. If there is any doubt on this point, pull the vertical oscillator tube and substitute a dummy tube with all but the heater pins cut off. This will permit you to check the pulse from the integrator without interference.

Check the integrator plate and its associated circuit components. Trace back with the scope to find out where you are losing the vertical sync pulse. This probably sounds peculiar, but it is not impossible for a brand-new integrator plate assembly to be defective.

Poor sync

A Bendix 21K3 chassis has poor vertical and horizontal sync, with sound and picture OK. The horizontal locking-in range is critical. Vertical lock-in is also critical. There is a horizontal pull in the picture about 2 inches from the top and varying the contrast control tends to straighten out the pulling. Changes in cameras or background will usually cause severe picture pulling, with buzz in the sound, after which the picture will stabilize. Vertical linearity is poor, with compression at the top.

The 6W6 runs extremely hot. The B-plus voltage at the cathode of the 6W6 measures 185. The set has too much width, which cannot be reduced, and the width control smokes whenever it is turned completely counterclockwise. The agc voltage at the plate of the 6AU6 keyer is −36.—R. C., Chicago, Ill.

In response to your query, it appears quite likely that the horizontal output tube is generating too much sweep voltage. This follows from the fact that the 6W6 runs hot, and that the B-plus voltage at the cathode of the audio output tube is high. Also, the output from the keyer tube is high, and the picture width is excessive, which all points to the same trouble.

You should find 60-volt (peak-to-peak) drive at the grid of the horizontal output tube. This can be quickly checked with a calibrated scope. Adjust the horizontal drive control, if necessary.

There should be 10-volt bias at the cathode of the horizontal-output tube. The 10-μf cathode-bypass capacitor could possibly be shorted if you find little or no bias here.

Likewise, you should find 165 volts at the screen of the horizontal output tube. If this voltage is high, you should check the .047-μf bypass capacitor for leakage. END

NEXT MONTH'S TV CLINIC

Faulty Tubes in the Color Section

By ROBERT B. COOPER, JR.

TIPS . . . from a TVDX-ers notebook

Types of dx reception and necessary receiving equipment and techniques

THE field and hobby of television dx-ing have grown to such proportions during the past 4 years that the number of dx-ers currently twirling the dials is estimated in the thousands. For most of them the only contact with other weak-signal chasers is through the TV dx column appearing in RADIO-ELECTRONICS on a regular basis (alternate months).

TV dx picked up in Fresno, California. Top, WBAP-TV, channel 5, Fort Worth, Texas, June, 1956. Center, KFEL-TV, channel 2, Denver, Colorado, July, 1955. Bottom, CHCT, channel 2, Calgary, Alberta, Canada, June, 1955.

Along with predictions of dx conditions and news of unusual loggings, we often receive requests for information pertaining to antennas, when to look for dx, receivers, accurate record keeping and many other phases of full-scale dx-ing. Here are a few tips for those who are interested in TV dx but may not know how to break into the field.

Receiving dx stations (those not normally seen at your location) is not nearly so much a function of the location of the observer and the equipment used as it is of being at the right place at the right time. In dx-ing circles many make use of a "timetable" (see table) to give basic information concerning the types of dx we might expect during various periods of the year. During a year's time seasonal weather changes and the position of the Earth in relation to the Sun and other heavenly bodies have pronounced effects on dx conditions.

Types of dx reception

The most common form of dx is that denoted by the term "sporadic-E skip." Sporadic-E skip (abbreviated Es) affects the lower television channels (2–6), bringing reception to your location from stations on an average of 500–1,500 miles distant. Various forms of Es have been known to provide reception for distances as great as 6,600 miles, although this is exceedingly rare. Es is a result of the television signal being reflected from a densely ionized layer, called the E layer, of the ionosphere. This layer exists at a height of 60–70 miles above the Earth. Under normal conditions the layer's density is very low and very-high-frequency television signals pass through the layer and on into space, never to return. It is only during periods of freak ionization conditions that the layer forms (actually forming in spots and not as a whole layer) and causes low-channel television signals to rebound from it as if it were a mirror.

Occurring on all TV channels, but most pronounced on high-band (channels 7-13) vhf and on uhf, is tropospheric (abbreviated trops) bending or conveyance of television waves to areas beyond the radio horizon via the troposphere. The tropospheric layer exists immediately adjacent to the Earth, and the majority of our weather occurs in it. Trops is actually caused by sharp boundaries formed in weather fronts which act as a duct, carrying the signal to distant points. This form of reception occurs, for the most part, during the spring, early summer and early fall months of the year. Distances covered vary from 200–800 miles.

A form of dx-ing theoretically possible, during the next few years at least, is F2 skip. Like the E layer, the F2 layer of the ionosphere is often capable of reflecting television signals back to Earth during years of peak sunspot activity. The channels influenced most often by this form of skip are the lowest (2–4). The distances covered by F2 are enough to stagger even the most imaginative mind, beginning at 2,200 miles and working upward in steps of 2,000 miles at a time. This form of dx-ing promises to be extra interesting as it will provide us with the opportunity to view programs originating in other countries and even other continents!

Lastly, we have what is commonly known as the dx-ers' form of dx. As sensitive receiver design developed to usable levels and antennas with higher gain were put on the market, alert observers began to notice a form of burst reception. Short bursts of reception could be obtained for seconds at a time during periods when no signs of dx were present. It was decided that these bursts were a result of meteorites entering the E layer of the ionosphere and burning up there. As the friction causes them to burn, they leave a trial of ionized gas. Thus, like regular Es, meteor bursts (or MS) could provide reception from stations 500–1,500 miles distant. As meteorites are entering the E layer at all times (though in varying degrees of intensity), we are able to log distant stations whenever we wish. The only hitch in the scheme is the short duration of the bursts. It usually takes many bursts to identify

the program material and a few more to identify the source. Lots of patience and a good deal of practical experience really pay off with this form of dx-ing.

Keeping an accurate log is a very important part of dx-ing. As dx-ers, we are able to provide scientists with a great deal of information not obtainable in any other way. TV dx is definitely freakish in nature and is therefore subject to explanation. However, as with many other occurrences in nature, information is needed before detailed study may begin. RADIO-ELECTRONICS is providing without cost through the TV dx column specially prepared forms on which you may report your dx observations. When your reports are combined with those from other sections of the country, scientists get a broad view of dx conditions over the country as a whole for any given date. An accurate log is also important when you wish to write to stations requesting letters of verification for your reception. It is always best to include information as taken from the receiver screen or audio, referring to local advertisements, etc. This will help the station in verifying your report. Many dx-ers have verification letters from 100 or more stations.

Receiving equipment

During the past 2 to 3 years the oldtimers in the dx game have become increasingly aware of the fact that the newer television receivers are sadly lacking in many dx essentials. In fact, with the current drive to use multipurpose tubes, etc. for receiver compactness individual set gain and stability have deteriorated measurably. Therefore, dx-ers usually recommend that newcomers in the game purchase a sensitive receiver having a cascode front end (cascode rf stage). Keeping your receiver in good electrical working order is very important. If you do a moderate amount of dx-ing, change the rf amplifier tube every few months. Other important tubes such as the detectors, if amplifiers, rectifiers, etc. should all be tested frequently and perhaps changed completely every year. Remember, the only difference between the receiver you use for dx-ing and the one your neighbor uses for normal home viewing is the shape you keep yours in.

Boosters are also frequently mentioned. Remember this simple rule: If your receiver is of late-model design, with a cascode type rf amplifier stage, boosters are of very little value. Receivers using pentode and triode rf amplifier stages will benefit greatly from a cascode booster stage.

When we approach the question of the correct antenna for dx-ing purposes (or just plain deep-fringe reception), we encounter a controversy. Some dx-ers prefer large-screen reflector arrays with dipoles situated in front for signal pickup. Others lean toward the various forms of Yagi antennas while still others like the collinear style. To provide optimum gain on each channel with a single antenna is an engineering feat yet to be accomplished. However, several compromises may be made to give fair to good gain across the spectrum and still allow the use of a single antenna for all-channel vhf operation. What is wanted is as much gain as it is possible to get, high front-to-back ratio and good directivity. Many dx-ers use 5- or 10-element Yagi's for channel 2 and then some form of all-channel for the rest. The reason for this is that both Es and F2 work up from the lowest channels. Thus, a good antenna system on channel 2 is a big help. If you have a local on channel 2, a similar system for channel 3 would also serve the purpose. Stacking Yagi antenna arrays pays off for weak-signal reception.

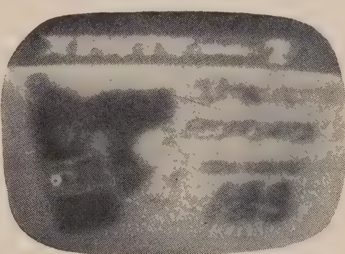
DX TIME TABLE

Period of year	Types of dx	Optimum Hours (Times 24-hour LST)	Data
Nov. 15–Feb. 15	Sporadic Es	0700–0900 1600–2100	Peak of minor Es season.
Feb. 1–May 1 Oct. 1–Dec. 1	F2 Skip	0700–1300 1100–1300	Stations to east in am; to south in late am, early pm; west in early p.m.
Aug. 9–15 Dec. 10–15 April 15–21	Meteor scatter dx peaks	0500–0900 1100–1400 1900–0100	Peak periods of meteorite showers, although MS is always active.
March 1–April 15	Trops dx (ground wave)	0500–0900 1900–0200	Usually produces excellent trops along the Gulf coast.
May 15–July 30	Trops dx	0600–1100 2000–0200	Excellent trops on occasion in Midwest and along Great Lakes.
Aug. 20–Oct. 10	Trops dx	no set time	Annual trops dx peak over entire country. Usually peaks in mid-September.
April 15–Aug. 15	Sporadic Es	0600–1000 1200–1400 1700–2200	Es hits phenomenal uprise in number of openings, with Es on 50% of the days from any given location.

Antenna transmission line is also important. Keep the line in as good physical condition as possible. Of course, the best line is that with the lowest signal loss: 300-ohm open-wire line does an admirable job and 450-ohm open-wire line is also very good. A problem here is matching the 450-ohm lead-in with a 300-ohm receiver input and 300-ohm antenna. If open wire can be used, we suggest the 300-ohm version. If you have problems with your open-wire line continually shorting to the mast or tower as you rotate the antenna, try using the 300-ohm tubular uhf line. The loss is very low and the plastic insulation keeps out moisture, dust, etc. Try to use just one piece of line from the receiver to the antenna as splices create more signal loss.

Getting your antenna high above ground and the surrounding objects is also of prime importance. If you live in an area with many power lines, poles, high trees, etc., raising your antenna above them will really help reception. Giving the antenna a clear shot at the dx stations is the whole idea in back of raising it into the heights. Power lines, rooftops, trees and the like all add to the amount of signal absorbed or reflected before it reaches your antenna. As you raise it up in the air, your antenna begins to break into signal levels that have not been decreased by absorption. A height of 70 feet above ground is a good minimum height for serious dx-ers, although good results can be had down to around 40 feet. A good rule might be: Raise the antenna as high as guy wire, guying space, pipe, neighborhood policy and your pocketbook allow.

Rotating the antenna can and does make all the difference in the world. Remember, you are using a high-gain antenna with its power punch concentrated in the forward direction. It is designed to reject signals from the rear and sides. Any one of the popular antenna rotators is recommended for dx reception from all directions.



Courtesy Richard Lowry, Temple, Tex.

XEW TV, channel 2, Mexico City, Mexico, seen in Temple, Tex., March, 1955.

When using a large Yagi antenna array be sure that it is at least four boomlengths above any surrounding objects like trees and rooftops. This will assure you of a proper radiation pattern. If you cannot erect a Yagi array so that it is several boomlengths

from any objects at the same height, it would be better to try some other form of antenna.

Dx tips

Venetian blinds: Horizontal bars move across the screen, alternating black and white. This is a sign of two (or more) stations on the same channel, the bars being what is commonly termed a beat note. The blind effect on a channel normally clear of them is the tipoff that some sort of dx is trying to appear. Careful orientation of the antenna will usually bring it in. If you are not able to bring the dx station through a local or sublocal station, find the antenna heading in which the interference is strongest and then check the rest of the channels for signs of other dx stations.

Frequent signal bursts on a clear channel: This is a sign of either a meteorite shower or the formation of a Es cloud. In either case you should stick around for the next few hours and make frequent channel checks.

Fringe-area stations lose their snow: This is a sure sign that good trop conditions are forming. First, determine in which direction the conditions are improving and then check the channels for weak stations not normally seen. (As fringe-area stations become of "local quality," dx stations appear with "fringe-area quality.")

If you live very near transmitters, there is not much that can be done for reception of dx stations on the same channels as the locals. For reception on adjacent channels, special traps can be used to filter out the overload from your locals, thus leaving the adjacent channels for dx reception. These adjacent-channel traps can do a lot for reception of Es signals. If you live 20 miles or so from the actual transmitter site, you should be able to bring strong E-skip stations in with the help of a folded-dipole antenna to attenuate the local station. The dipole antenna consists of a length of 300-ohm line cut to a half-wavelength on the interfering channel. Fed with another length of lead-in in the usual manner, you have a very effective antenna for cutting out locals by cancellation. Mount the dipole on a piece of board and experiment with it at various heights to find the highest you can go before getting into the extra-strong local signals. By carefully orienting the dipole, you will be able to "phase" out the local and allow the dx skip station to come through.

From several experiments made in California, we have found the best height above ground for the dipole is around 20 feet. For this antenna, height above ground is the all-important factor. If you wish to use a single dipole for the five low channels, find a compromise length in the vicinity of channel 4.

For the latest in dx information and predictions of things to come, watch RADIO-ELECTRONICS' TV dx column. END

A TALE FROM CUBA

By L. F. FENTON

ONE of our service technicians brought a TV set to the shop. He reported "It shows white streaks on the screen, as if the antenna connection were loose." I checked: as a matter of fact, it was loose.

The set works nicely, but after a while a flash appears on the screen, and then more of them. It seems there is some other fault besides the loose antenna. With a station tuned in, white horizontal streaks appear. Without a station, or with the antenna disconnected, there are no streaks, but bursts of dark dots. It seems there is some arcing in the set and its radiation enters through the front end. By removing the mixer tube—or any tube of the if or video strip—the dots disappear.

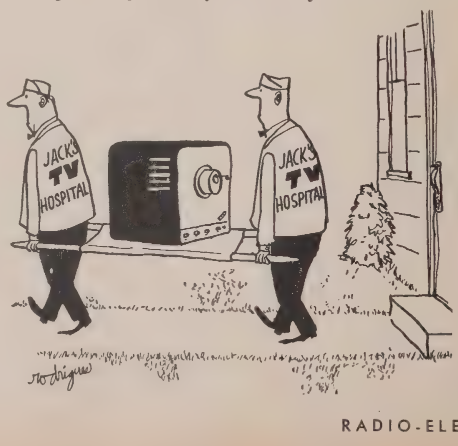
All that is left to do is to localize the arcing and remove it. Most probably some part of the high-voltage equipment is guilty. These parts are well secured in the high-voltage cage. Removing the cover, only the two high-voltage rectifier tubes and two 1.5-megohm resistors are visible. They are mounted on a piece of bakelite. The flyback transformer and the high-voltage filter capacitors are mounted on the rear of this form, and remain entirely hidden in the high-voltage cage. So I decided to go the easy way: check first the parts outside the cage. The arcing most likely occurs at the connection of the high-voltage lead to the metal picture tube; so I tighten it carefully. No result. Perhaps the horizontal output tube: I change it; I change the horizontal oscillator, the damper and the high-voltage rectifiers too. No result. The 1.5-megohm resistors check OK with an ohmmeter; but to be on the safe side, I exchange them. No result. I put a new picture tube in the set. I try to tap gently (well, more or less gently) all tubes and other parts. I cannot provoke the streaks by tapping, moving, pushing or pulling any part of the set. On the contrary, the streaks seem to occur independently of any human influence. Very intriguing!

So then I disconnect a number of leads, remove the picture tube, the yoke and the cage to get at the flyback. Should this be the bad part, it would be a minor tragedy. It is of special construction, a standard flyback does not fit easily. Checking with an ohmmeter shows that the high-voltage winding is open; evidently it arcs inside the coil. So I have found it at last.

I install a new flyback. Yes, it behaves itself. I watch it several minutes. But what is this? Again a streak; then several more. These streaks do not appear as often as before, but they are *most* annoying. Is it possible that the brand-new flyback is defective? Out comes the high-voltage supply. The flyback checks OK with the ohmmeter. And I can see absolutely no trace of corona—only the streaks on the screen which are really annoying (or am I repeating myself?).

I decide to make another experiment. To localize the arcing I connect the video output of the sick set into the C-R tube of a second set. This arrangement works fine—picture and streaks appear on this tube too. Then I disable the high-voltage supply of the first set, removing the horizontal output tube—the streaks remain. I remove the horizontal and vertical oscillators and the sound section, with the same result. So it is definitely established, the fault is not in the high-voltage supply, neither in the vertical or sound section. In fact, the only remaining part in the front end, if and video strip and the low-voltage supply.

First I replace the front end. And believe it or not, for the first time there *is* a result, the streaks disappear. Well, to make a long story short, besides the flyback, a coil in the front end was guilty. It was open (ohmmeter reading more than 1,000 megohms), but it passed the whole plate voltage to the mixer tube. Evidently it arced. Replacing it with a new one, the set worked smoothly. END



Practical COLOR Installation

Part III—Wherein Red gives Fuzzball the pitch on horizontal dynamic convergence

By BOB MIDDLETON

THEY ought to make the cook drink this coffee," Fuzzball grumbled.

"That would be unconstitutional," Red observed; "cruel and unusual punishment. Besides, he's big enough and mean enough to make *you* drink it."

"Not to change the subject," replied Fuzzball, "but what's the pitch on *horizontal* dynamic convergence? You got me clued in pretty good on the vertical."

"Well, now," Red said slowly, "you'll find that horizontal isn't too much different from vertical. Unless, of course, you start getting some of them queer notions of yours."

"I'll pretend I didn't hear that last remark," replied Fuzzball evenly. "Should I keep the center of screen in convergence with the beam magnets while I'm working with the horizontal dynamic?"

Red turned to the tired-looking waitress. "Give the man a five-cent cigar, Bessie. He's hot as a pistol today."

Bess started to open the corner of her mouth and then shut it again.

"It figures," explained Fuzzball, "because that's what works out best when you're working with the vertical dynamic controls."

"Tell me more," Red said encouragingly.

"You tell me," protested Fuzzball. "What do I do next?"

"Well, you should start by resonating the horizontal phasing coils."

"Come again, already?"

"First turn the blue amplitude control to maximum," Red explained patiently. "Then turn the core in the blue phasing coil to curve the dots or lines to a peak or dip in the center of the screen. Look, I got a photo here that I tore out of RADIO-ELECTRONICS." [See photo at head of article, also Fig. 1-a.—*Editor*]

"Why?" asked Fuzzball.

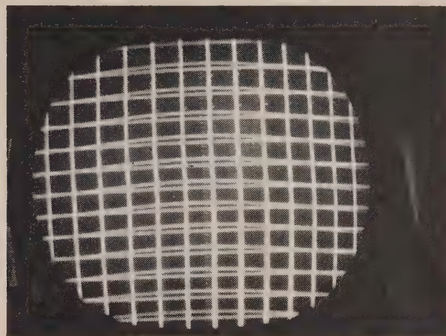
"Because I wanted to keep it to refer to," snapped Red.

"I mean, why do you want to resonate the phasing coil?" protested Fuzz.

"Simple, you simple boy," Red explained, "because then you will have the coil pretty near its final setting. Saves a lot of wasted time."

"And you do the same thing with the

(*Continued on page* 78)



The photo that Red—by coincidence—had torn out of Radio-Electronics.

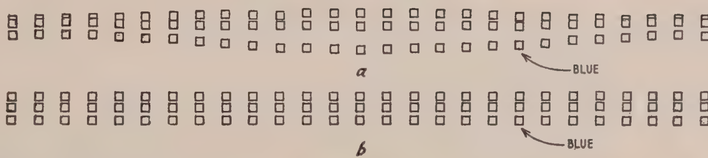


Fig. 1—"Turn the core in the blue phasing coil to curve the dots to a dip in the center (a) . . . then adjust the horizontal amplitude control to get a good straight line (b)."

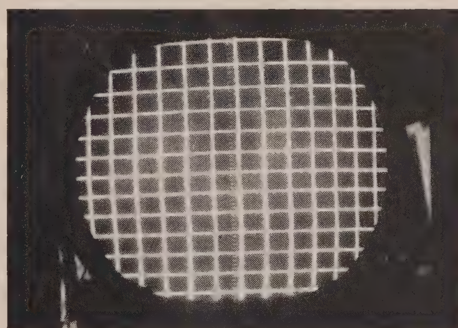


Fig. 2.—". . . another photo showing this desirable situation."

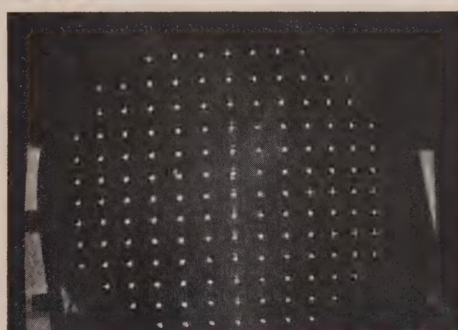


Fig. 3—"The crosshatch pattern doesn't show up miscovergence nearly as plain as the little dots."

TIME PAYMENTS . . .

The Heath Time Payment Plan was designed for your convenience. Now, you can order the kits of your choice, and pay for them in small monthly installments. Write for full details.

HEATHKIT EXTRA PERFORMANCE 70-WATT AMPLIFIER KIT

For really high performance, with plenty of reserve power, the W-6M is a natural. The full 70-watts output will seldom, if ever, be required. However, this reserve insures distortion-less sound on power peaks. The W-6M will loaf along at normal listening levels and yet is always ready to extend itself when program material demands it, without the least amount of strain. The output circuit employs 6550 tubes with a special-design Peerless output transformer for maximum stability at all power levels. A quick-change plug selects 4, 8 and 16 ohms or 70-volt output and the correct feedback resistance. A variable damping control is also provided for optimum performance with any speaker system. Extremely good power supply regulation is possible through the use of a heavy-duty transformer along with silicon-diode rectifiers, which are noted for their very long life, and yet are smaller than a house fuse. Frequency response at 1 watt is ±1 db from 5 cps to 80 kc with controlled hf rolloff above 100 kc. At 70 watts output harmonic distortion is below 2%, 20 to 20,000 cps and IM distortion below 1%, 60 and 6,000 cps. Hum and noise 88 db below full output. In addition to high performance, its fine appearance makes it a pleasure to display in your living room. Proper layout of chassis insures ease of assembly by eliminating those cramped and difficult places to get at. Clear instructions—and top-quality components. Get started now and make this amplifier the heart of your hi-fi system. Shipped express only. Shpg. Wt. 50 lbs.

MODEL W-6M **$109.95**

MODEL W-6: Consists of W-6M kit, plus WA-P2 preamplifier. Express only. Shpg. Wt. 59 lbs. $129.70

HEATHKIT HIGH FIDELITY FM TUNER KIT

This tuner can bring you a rich store of FM programming, your least expensive source of high fidelity material. It covers the complete FM band from 88 to 108 mc. Stabilized, temperature-compensated oscillator assures negligible drift after initial warmup. Features broadbanded circuits for full fidelity, and better than 10 uv sensitivity for 20 db of quieting, to pull in stations with clarity and full volume. Employs a high gain, cascode RF amplifier, and has AGC. A ratio detector provides high-efficiency demodulation without sacrificing hi-fi performance. IF and ratio transformers are prealigned, as is the front end tuning unit. Special alignment equipment is not necessary. Edge-lighted glass dial for easy tuning. Here is FM for your home at a price you can afford. Shpg. Wt. 8 lbs.

MODEL FM-3A **$25.95** *(with cabinet)*

HEATHKIT BROADBAND AM TUNER KIT

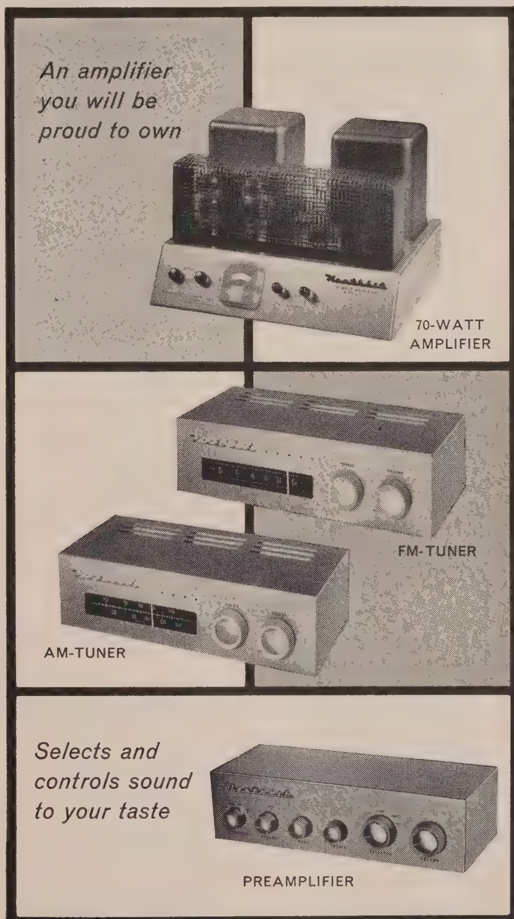
This AM tuner was designed especially for high fidelity applications. It incorporates a special detector using crystal diodes, and the IF circuits feature broad band-width, to insure low signal distortion. Audio response is ±1 db from 20 cps to 9 kc, with 5 db of preemphasis at 10 kc to compensate for station rolloff. Sensitivity and selectivity are excellent, and tuner covers complete broadcast band from 550 to 1600 kc. Quiet performance is assured by 6 db signal-to-noise ratio at 2.5 UV. Prealigned RF and IF coils eliminate the need for special alignment equipment. Incorporates AVC, two outputs, two antenna inputs, and built-in power supply. Edge-lighted glass slide-rule dial for easy tuning. Your "best buy" in an AM tuner. Shpg. Wt. 8 lbs.

MODEL BC-1A **$25.95** *(with cabinet)*

HEATHKIT MASTER CONTROL PREAMPLIFIER KIT

Designed for use with any of the Williamson-type amplifiers, the WA-P2 has five switch-selected inputs, each having its own level control to eliminate blasting or fading while switching through the various inputs, plus a tape recorder output. A hum control allows setting for minimum hum level. Frequency response is within ±1½ db from 15 to 35,000 cps. Equalization provided for LP, RIAA, AES, and early 78's. Separate bass and treble controls. Low impedance cathode follower output circuit. All components were specially selected for their high quality. Includes many features which will eventually be desired. Shpg. Wt. 7 lbs.

MODEL WA-P2 **$19.75** *(with cabinet)*



HEATH COMPANY *A Subsidiary of Daystrom, Inc.* **BENTON HARBOR 20, MICH.**

HEATHKIT "BASIC RANGE" HI-FI SPEAKER SYSTEM KIT

The extremely popular Heathkit model SS-1 Speaker System provides amazing high fidelity performance for its size. Features two high-quality Jensen speakers, an 8" mid-range woofer and compression-type tweeter with flared horn. Covers from 50 to 12,000 CPS within ±5 db, in a special-design ducted-port, bass reflex enclosure. Impedance is 16 ohms. Cabinet measures 11½" H x 23" W x 11¾" D. Constructed of veneer-surfaced plywood, ½" thick, suitable for light or dark finish. All wood parts are precut and predrilled for easy, quick assembly. Shpg. Wt. 30 lbs.

MODEL SS-1

$39.95

HEATHKIT "RANGE EXTENDING" HI-FI SPEAKER SYSTEM KIT

Extends the range of the SS-1 to ±5 db from 35 to 16,000 CPS. Uses 15" woofer and super-tweeter both by Jensen. Kit includes crossover circuit. Impedance is 16 ohms and power rating is 35 watts. Measures 29" H x 23" W x 17½" D. Constructed of veneer-surfaced plywood ¾" thick. Easy to build! Shpg. Wt. 80 lbs.

MODEL SS-1B

$99.95

HEATHKIT "LEGATO" HIGH FIDELITY SPEAKER SYSTEM KIT

The quality of the Legato, in terms of the engineering that went into the initial design, and in terms of the materials used in its construction, is matched in only the most expensive speaker systems available today. The listening experience it provides approaches the ultimate in esthetic satisfaction. Two 15" theater-type Altec Lansing speakers cover 25 to 500 CPS, and an Altec Lansing high-frequency driver with sectoral horn covers 500 to 20,000 CPS. A precise amount of phase shift in the crossover network brings the high frequency channel into phase with the low frequency channel to eliminate peaks or valleys at the crossover point, by equalizing the acoustical centers of the speakers. The enclosure is a modified infinite baffle type, especially designed for these speakers. Cabinet is constructed of veneer-surfaced plywood, ¾" thick, precut and predrilled for easy assembly. Frequency response 25 to 20,000 CPS. Power rating, 50 watts program material. Impedance is 16 ohms. Cabinet dimensions 41" L x 22¼" D x 34" H.

Choice of two beautiful cabinets. Model HH-1-C in imported white birch for light finishes, and HH-1-CM in African mahogany for dark finishes. Shpg. Wt. 195 lbs.

MODEL HH-1-C
MODEL HH-1-CM

$325.00
EACH

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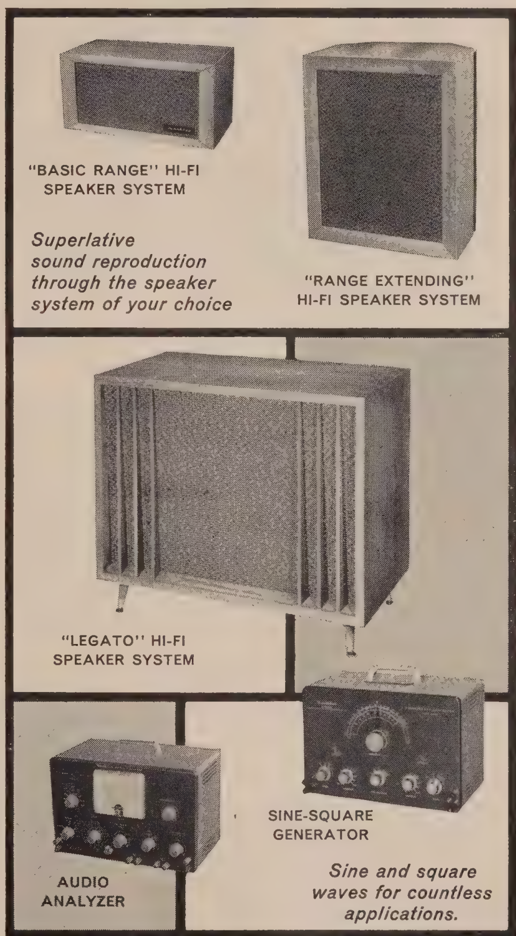
let you save up to ½ or more on all types of electronic equipment.



HEATHKIT SINE-SQUARE GENERATOR

The new AG-10 provides high quality, sine and square waves over a wide range, for countless applications. Some of these are; radio and TV repair work, checking scope performance, as a variable trigger source for telemetering and pulse work, and checking audio, video and hi-fi amplifier response. Frequency response is ±1.5 db from 20 CPS to 1 MC on both sine and square waves, with less than .25% sine wave distortion, 20 to 20,000 CPS. Sine wave output impedance 600 ohms, square wave output impedance 50 ohms, (except on 10v ranges). Square wave rise time less than .15 usec. Five-position band switch—continuously variable tuning—shielded oscillator circuit—separate step and variable output attenuators in ranges of 10, 1, and .1 volts for both sine and square wave, with extra range of .01 volt on sine wave. Both sine and square wave can be used at the same time without affecting either wave form. Power supply uses silicon-diode rectifiers. Shpg. Wt. 12 lbs.

MODEL AG-10

$49.95

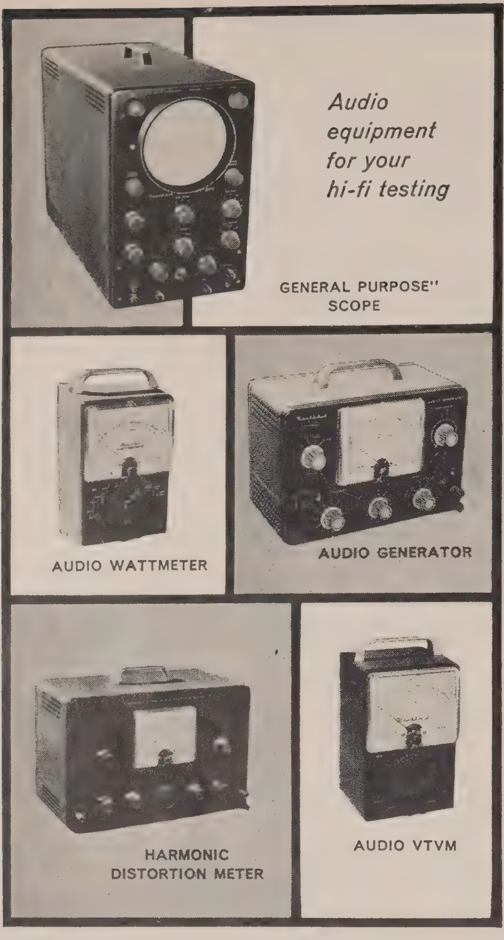
HEATHKIT AUDIO ANALYZER KIT

The AA-1 is actually three instruments in one compact package. It combines the functions of an AC VTVM, an audio wattmeter, and an intermodulation analyzer. Input and output terminals are combined, and high and low frequency oscillators are built in. VTVM ranges are 0-.01, .03, .1, .3, 1, 3, 10, 30, 100 and 300 volts (RMS). Wattmeter ranges are .15 mw, 1.5 mw, 15 mw, 150 mw, 1.5 w, 15 w and 150 w. IM scales are 1%, 3%, 10%, 30% and 100%. Provides internal load resistors of 4, 8, 16 or 600 ohms. A tremendous dollar value. Shpg. Wt. 13 lbs.

MODEL AA-1

$49.95

HEATH COMPANY *A Subsidiary of Daystrom, Inc.* **BENTON HARBOR 20, MICH.**



HEATHKIT "GENERAL PURPOSE" 5" OSCILLOSCOPE KIT

The model OM-2 Oscilloscope is especially popular with part-time service technicians, students, and high fidelity enthusiasts. It features good vertical frequency response ±3 db from 4 cps to over 1.2 mc. A full five-inch crt, and sweep generator operation from 20 cps to over 150 kc. Stability is excellent and calibrated grid screen allows precise signal observation. Extra features include external or internal sweep and sync, 1-volt peak-to-peak calibrating reference, 3-position step-attenuated input, adjustable spot shape control, push-pull horizontal and vertical amplifiers, and modern etched-metal circuits. Easy to build and a pleasure to use. Ideal for use with other audio equipment for checking amplifiers. Shpg. Wt. 21 lbs.

MODEL OM-2 $42.50

HEATHKIT AUDIO WATTMETER KIT

The AW-1 Audio Wattmeter can be used in any application where audio power output is to be measured. Non-inductive LOAD resistors are built in for 4, 8, 16 or 600 ohms impedance. Five power ranges cover 0-5 mw, 50 mw, 500 mw, 5 w, and 50 w full scale. Five switch-selected db ranges cover −10 db to +30 db. All indications are read directly on a large 4½" 200 microampere meter. Frequency response is ±1 db from 10 cps to 250 kc. Precision type multiplier resistors used for high accuracy, and crystal diode bridge for wide-range frequency response. This meter is used in many recording studios and broadcast stations as a monitor as well as servicing. A fine meter to help supply the answers to your audio operating or power output problems. Shpg. Wt. 6 lbs.

MODEL AW-1 $29.50

HEATHKIT AUDIO SIGNAL GENERATOR KIT

The model AG-9A is "made to order" for high fidelity applications, and provides quick and accurate selection of low-distortion signals throughout the audio range. Three rotary switches select two significant figures and a multiplier to determine audio frequency. Incorporates step-type and a continuously variable output attenuator. Output indicated on large 4½" panel meter, calibrated in volts and db. Attenuator system operates in 10 db steps, corresponding to meter calibration, in ranges of 0-.003, .01, .03, .1, .3, 1,3 and 10 volts RMS. "Load" switch permits use of built-in 600-ohm load, or external load of different impedance. Output and frequency indicators accurate to within ±5%. Distortion less than .1 of 1% between 20 and 20,000 cps. Total range is 10 cps to 100 kc. Shpg. Wt. 8 lbs.

MODEL AG-9A $34.50

HEATHKIT HARMONIC DISTORTION METER KIT

All sounds consist of dominant tones plus harmonics (overtones). These harmonics enrich the quality and brightness of the music. However, additional harmonics which originate in the audio equipment, represent distortion. Used with an audio signal generator, the HD-1 will accurately measure this harmonic distortion at any or all frequencies between 20 and 20,000 cps. Distortion is read directly on the panel meter in ranges of 0-1, 3, 10, 30 and 100% full scale. Voltage ranges of 0-1, 3, 10 and 30 volts are provided for the initial reference settings. Signal-to-noise ratio measurements are also permitted through the use of a separate meter scale calibrated in db. High quality components insure years of outstanding performance. Full instructions are provided. Shpg. Wt. 13 lbs.

MODEL HD-1 $49.50

Heathkits...

By DAYSTROM

are well known for their high quality and reliability.

HEATHKIT AUDIO VTVM KIT

This new and improved AC Vacuum Tube Voltmeter is designed especially for audio measurements and low-level AC measurements in power supply filters, etc. Employs an entirely new circuit featuring a cascode amplifier with cathode-follower isolation between the input and the amplifier, and between the output stage and the preceding stages. It emphasizes stability, broad frequency response, and sensitivity. Frequency response is essentially flat from 10 cps to 200 kc. Input impedance is 1 megohm at 1000 cps. AC (RMS) voltage ranges are 0-.01, .03, .1, .3, 1, 3, 10, 30, 100 and 300 volts. Db ranges cover −52 db to +52 db. Features large 4½" 200 microampere meter, with increased damping in meter circuit for stability in low frequency tests. 1% precision resistors employed for maximum accuracy. Stable, reliable performance in all applications. Shpg. Wt. 5 lbs.

MODEL AV-3 $29.95

HEATHKIT COLOR BAR AND DOT GENERATOR

The CD-1 combines the two basic color service instruments, a Color Bar Generator and White Dot Generator in one versatile portable unit, which has crystal-controlled accuracy and stability (no external sync lead required). Produces white-dots, cross hatch, horizontal and vertical bars, 10 vertical color bars, and a new shading bar pattern for screen and background adjustments. Variable RF output on any channel from 2 to 6. Positive or negative video output, variable from 0 to 10 volts peak-to-peak. Crystal controlled sound carrier with off-on switch. Voltage regulated power supply using long-life silicon rectifiers. Gain knowledge of a new and profitable field by constructing this kit. Shpg. Wt. 12 lbs.

MODEL CD-1

$59.95

Heathkits...

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are guaranteed to meet or exceed advertised specifications

HEATHKIT TV ALIGNMENT GENERATOR KIT

This fine TV alignment generator offers stability and flexibility difficult to obtain even in instruments costing several times this low Heathkit price. It covers 3.6 mc to 220 mc in four bands. Sweep deviation is controllable from 0 to 42 mc. The all-electronic sweep circuit insures stability. Crystal marker and variable marker oscillators are built in. Crystal (included with kit) provides output at 4.5 mc and multiples thereof. Variable marker provides output from 19 to 60 mc on fundamentals and from 57 to 180 mc on harmonics. Effective two-way blanking to eliminate return trace. Phasing control. Kit is complete, including three output cables. Shpg. Wt. 16 lbs.

MODEL TS-4A

$49.50

HEATHKIT "EXTRA DUTY" 5" OSCILLOSCOPE KIT

This fine oscilloscope compares favorably to other scopes costing twice its price. It contains the extra performance so necessary for monochrome and color-TV servicing. Features push-pull horizontal and vertical output amplifiers, a 5UPI CRT, built in peak-to-peak calibration source, a fully compensated 3-position step-type input attenuator, retrace blanking, phasing control, and provision for Z-axis modulation. Vertical amplifier frequency response is within +1.5 and −5 db from 3 CPS to 5 MC. Response at 3.58 MC down only 2.2 db. Sensitivity is 0.025 volts RMS/inch at 1 kc. Sweep generator covers 20 CPS to 500 kc in five steps, five times the usual sweep obtained in other scopes through the use of the patented Heath sweep circuit. Etched-metal circuit boards reduce assembly time and minimize errors in assembly, and more importantly, permit a level of circuit stability never before achieved in an oscilloscope of this type. Shpg. Wt. 21 lbs.

MODEL O-11

$69.50

HEATHKIT ELECTRONIC SWITCH KIT

A valuable accessory for any oscilloscope owner. It allows simultaneous oscilloscope observation of two signals by producing both signals, alternately, at its output. Four switching rates. Provides gain for input signals. Frequency response ±1 db, 0 to 100 kc. A sync output is provided to control and stabilize scope sweep. Ideal for observing input and output of amplifiers simultaneously. Shpg. Wt. 8 lbs.

MODEL S-3

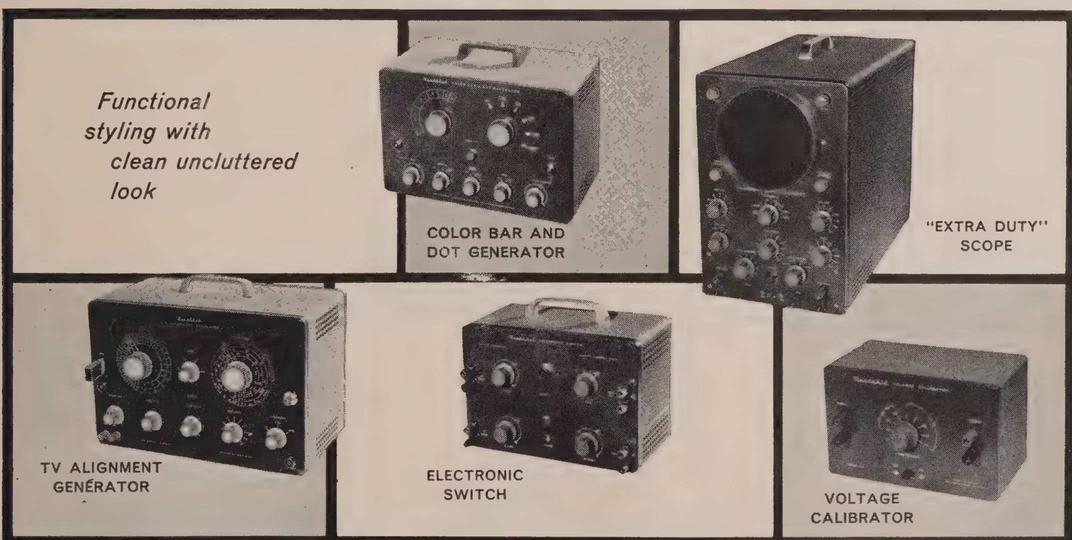
$21.95

HEATHKIT VOLTAGE CALIBRATOR KIT

This unit is an excellent companion for your oscilloscope. Used as a source of calibrating voltage, it produces near-perfect square wave signals of known amplitude. Precision 1% attenuator resistors insure accurate output amplitude, and multivibrator circuit guarantees good sharp square waves. Output frequency is approximately 1000 CPS. Fixed outputs selected by panel switches are; .03, 0.1, 0.3, 1.0, 3.0, 10, 30 and 100 volts peak-to-peak. Allows measurment of unknown signal amplitude by comparing it to the known output of the VC-3 on oscilloscope. Shpg. Wt. 4 lbs.

MODEL VC-3

$12.50



HEATH COMPANY *A Subsidiary of Daystrom, Inc.* **BENTON HARBOR 20, MICH.**

HEATHKIT TUBE CHECKER KIT

Eliminate guesswork, and save time in servicing or experimenting. The TC-2 tests tubes for shorted elements, open elements, filament continuity, and operating quality on the basis of total emission. It tests all tube types encountered in radio and TV service work. Sockets are provided for 4, 5, 6 and 7-pin, octal, and loctal tubes, 7 and 9 pin miniature tubes, 5 pin hytron miniatures, and pilot lamps. Tube condition indicated on 4½" meter with multi-color "good-bad" scale. Illuminated roll chart with all test data built in. Switch selection of 14 different filament voltages from .75 to 117 volts. Color-coded cable harness allows neat professional wiring and simplifies construction. Very easy to build, even for a beginner. Shpg. Wt. 12 lbs.

MODEL TC-2

$29.50

HEATHKIT HANDITESTER KIT

The small size and rugged construction of this tester makes it perfect for any portable application. The combination function-range switch simplifies operations. Measures AC or DC voltage at 0-10, 30, 300, 1000 and 5000 volts. Direct current ranges are 0-10 ma and 0-100 ma. Ohmmeter ranges are 0-3000 (30 ohm center scale) and 0-300,000 (3000 ohm center scale). Very popular with home experimenters, electricians, and appliance repairmen. Slips easily into your tool box, glove compartment, coat pocket, or desk drawer. Shpg. Wt. 3 lbs.

MODEL M-1

$14.50

HEATHKIT PICTURE TUBE CHECKER KIT

The CC-1 can be taken with you on service calls so that you can clearly demonstrate the quality of a customer's picture tube in his own home. Tubes can be tested without removing them from the receiver or cartons if desired. Checks cathode emission, beam current, shorted elements, and leakage between elements in electromagnetic picture tube types. Self-contained power supply, and large 4½" meter. CRT condition indicated on "good-bad" scale. Relative condition of tubes fluorescent coating is shown in "shadowgraph" test. Permanent test cable with CRT socket and anode connector. No tubes to burn out, designed to last a lifetime. Luggage-type portable case. Shpg. Wt. 10 lbs.

MODEL CC-1

$22.50

HEATHKIT ETCHED-CIRCUIT VTVM KIT

This multi-purpose VTVM is the world's largest selling instrument of its type—and is especially popular in laboratories, service shops, home workshops and schools. It employs a large 4½" panel meter, precision 1% resistors, etched metal circuit board, and many other "extras" to insure top quality and top performance. It's easy to build, and you may rely on its accuracy and dependability. The V7-A will measure AC (RMS) and DC voltages in ranges of 0-1.5, 5, 15, 50, 150, 500 and 1500. It measures peak-to-peak AC voltage in ranges of 0-4, 14, 40, 140, 400, 1400 and 4000. Resistance ranges provide multiplying factors of X 1, X 10, X 100, X 1000, X 10k, X 100k, and X 1 megohm. Center-scale resistance readings are 10, 100, 1000, 10k, 100k, 1 megohm and 10 megohms. A db scale is also provided. The precision and quality of this VTVM cannot be duplicated at this price. Shpg. Wt. 7 lbs.

MODEL V7-A

$24.50

Heathkits...

By DAYSTROM

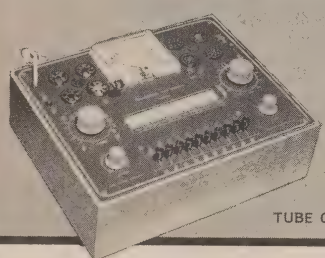
let you fill your exact needs from a wide variety of instruments

HEATHKIT 20,000 OHMS/VOLT VOM KIT

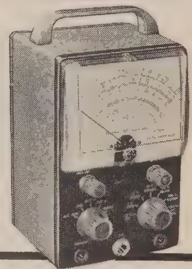
This fine instrument provides a total of 25 meter ranges on its two-color scale. It employes a 50 ua 4½" meter, and features 1% precision multiplier resistors. Requires no external power. Ideal for portable applications. Sensitivity is 20,000 ohms-per-volt DC and 5000 ohms-per-volt AC. Measuring ranges are 0-1.5, 5, 50, 150, 500, 1500 and 5000 volts, AC and DC. Measures direct current in ranges of 0-150 ua, 15 ma, 150 ma, 500 ma and 15 a. Resistance multipliers are X 1, X 100 and X 10,000, with center-scale readings of 15, 1500 and 150,000 ohms. Covers −10 db to +65 db. Easy to build and fun to use. Attractive bakelite case with plastic carrying handle. Shpg. Wt. 6 lbs.

MODEL MM-1

$29.50



TUBE CHECKER

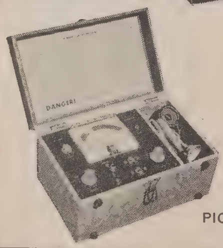


High quality test gear you will be proud to own

ETCHED CIRCUIT VTVM

Priced low to fit your budget

HANDITESTER



PICTURE TUBE CHECKER

20,000 OHMS/VOLT VOM

HEATHKIT IMPEDANCE BRIDGE KIT

The model IB-2A employs a Wheatstone Bridge, a Capacity Comparison Bridge, a Maxwell Bridge, and a Hay Bridge in one compact package. Measures resistance from 0.1 ohm to 10 megohms, capacitance from 100 mmf to 100 mfd, inductance from 0.1 mh to 100 h, dissipation factor (D) from 0.002 to 1, and storage factor (Q) from 0.1 to 1000. A 100-0-100 ua meter provides for null indications. The decade resistors employed are of 1% tolerance for maximum accuracy. Completely self-contained. Has built in power supply, 1000-cycle generator, and vacuum-tube detector. Special two-section CRL dial insures convenient operation. Instruction manual has entirely new schematic that clarifies circuit functions in various switch positions. A true laboratory instrument, that will provide you with many years of fine performance. Shpg. Wt. 12 lbs.

MODEL IB-2A **$59.50**

HEATHKIT "LOW RIPPLE" BATTERY ELIMINATOR KIT

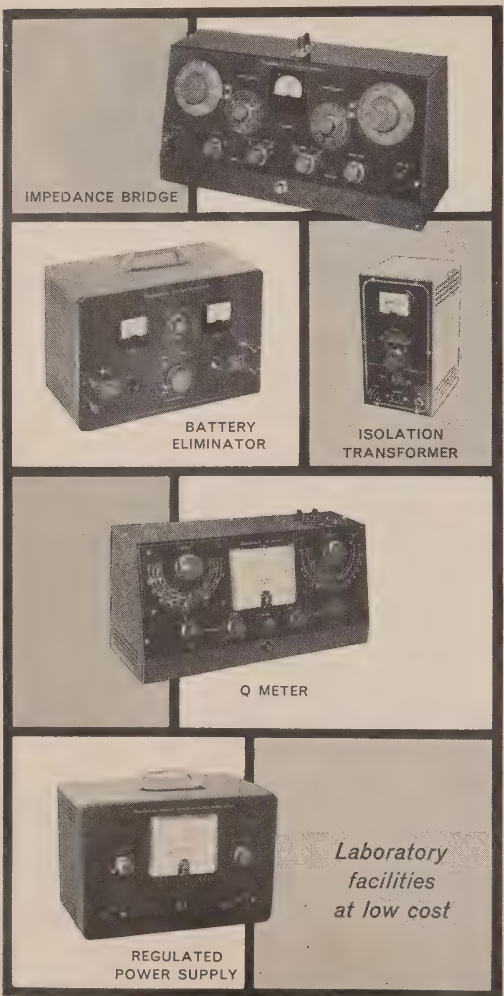
This modern battery eliminator incorporates an extra low-ripple filter circuit so that it can be used to power all the newest transistor-type circuits requiring 0 to 12 volts DC, and the new "hybrid" automobile radios using both transistors and vacuum tubes. Its DC output, at either 6 or 12 volts, contains less than .3% AC ripple. Separate output terminals are provided for low-ripple or normal filtering. Supplies up to 15 amps on 6 volt range or up to 7 amps on 12 volt range. Output is variable from 0 to 8 or 0 to 16 volts. Two meters constantly monitor output voltage and current. Will also double as a battery charger. Shpg. Wt. 23 lbs.

MODEL BE-5 **$39.95**

HEATHKIT ISOLATION TRANSFORMER KIT

The model IT-1 is one of the handiest units for the service shop, home workshop or laboratory. Provides complete isolation from the power line. AC-DC sets may be plugged directly into the IT-1 without the chassis becoming "hot". Output voltage is variable from 90 volts to 130 volts allowing checks of equipment under adverse conditions such as low line voltage. Rated for 100 volt amperes continuously or 200 volt amperes intermittently. Panel meter monitors output voltage. Shpg. Wt. 9 lbs.

MODEL IT-1 **$16.50**



Heathkits...

By DAYSTROM

are designed with high-quality, name-brand components to insure long service life

HEATHKIT "Q" METER KIT

At this price the laboratory facilities of a Q Meter may be had by the average service technician or home experimenter. The Q Meter permits measurement of inductance from 1 microhenry to 10 milihenry, "Q" on a scale calibrated up to 250 full scale, with multipliers of 1 or 2, and capacitance from 40 mmf to 450 mmf ± 3 mmf. Built in oscillator permits testing components from 150 kc to 18 mc. Large 4½" panel meter is featured. Very handy for checking peaking coils, chokes, etc. Use to determine values of unknown condensers, both variable and fixed, compile data for coil winding purposes, or measure RF resistance. Also checks distributed capacity and Q of coils. No special equipment is required for calibration. A special test coil is furnished, along with easy-to-follow instructions. Shpg. Wt. 14 lbs.

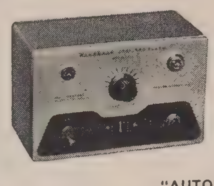
MODEL QM-1 **$44.50**

HEATHKIT REGULATED POWER SUPPLY KIT

Here is a power supply that will provide DC plate voltage and AC filament voltage for all kinds of experimental circuits. The DC supply is regulated for stability, and yet the amount of DC output voltage available from the power supply can be controlled manually from 0 up to 500 volts. At 450 volts DC output, the power supply will provide up to 10 ma of current, and provide progressively higher current as the output voltage is lowered. Current rating is 130 ma at 200 volts output. In addition to furnishing B+ the power supply also provides 6.3 volts AC at up to 4 amperes for filaments. Both the B+ output and the filament output are isolated from ground. Ideal unit for use in laboratory, home workshop, ham shack, or service shop. A large 4½" meter on the front panel reads output voltage or output current, selectable with a panel switch. Shpg. Wt. 17 lbs.

MODEL PS-3 **$35.50**

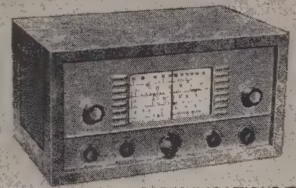
Automatically turns off transmitter and gives visual signal



"AUTOMATIC" CONELRAD ALARM

GRID DIP METER

"Q" MULTIPLIER



COMMUNICATIONS TYPE RECEIVER

An ideal receiver for the beginning ham or short wave listener

HEATHKIT "AUTOMATIC" CONELRAD ALARM KIT

This conelrad alarm works with any radio receiver; AC-DC-transformer operated—or battery powered, so long as the receiver has AVC. Fully complies with FCC regulations for amateurs. When the monitored station goes off the air, the CA-1 automatically cuts the AC power to your transmitter, and lights a red indicator. A manual "reset" button reactivates the transmitter. Incorporates a heavy-duty six-ampere relay, a thyratron tube to activate the relay, and its own built-in power supply. A neon lamp shows that the alarm is working, by indicating the presence of B+ in the alarm circuit. Simple to install and connect. Your transmitter plugs into an AC receptacle on the CA-1, and a cable connects to the AVC circuit of a nearby receiver. A built-in sensitivity control allows adjustment to various AVC levels. Receiver volume control can be turned up or down, without affecting alarm operation. Build a Heathkit CA-1 in one evening and comply with FCC regulations now! Shpg. Wt. 4 lbs.

MODEL CA-1
$13.95

HEATHKIT "Q" MULTIPLIER KIT

The Heathkit Q Multiplier functions with any AM receiver having an IF frequency between 450 and 460 KC, that is not "AC-DC" type. It derives its power from the receiver, and needs only 6.3 volts AC at 300 ma (or 12 VAC at 150 ma) and 150 to 250 volts DC at 2 ma. Simple to connect with cable and plugs supplied. Adds additional selectivity for separating signals, or will reject one signal and eliminate heterodyne. A tremendous help on crowded phone and CW bands. Effective Q of 4000 for sharp "peak" or "null". Tunes any signal within IF band pass without changing the main receiver tuning dial. A convenient tuning knob on the front panel with vernier reduction between the tuning knob and the tuning capacitor gives added flexibility in operation. Uses a 12AX7 tube, and special high-Q shielded coils. Instructions for connecting to the receiver and operation are provided in the construction manual. A worthwhile addition to any communications, or broadcast receiver. It may also be used with a receiver which already has a crystal filter to obtain two simultaneous functions, such as peaking the desired signal with the crystal filter and nulling an adjacent signal with the Q Multiplier. Shpg. Wt. 3 lbs.

MODEL QF-1
$9.95

HEATHKIT GRID DIP METER KIT

A grid dip meter is basically an RF oscillator for determining the frequency of other oscillators, or of tuned circuits. Extremely useful in locating parasitics, neutralizing, identifying harmonics, coil winding, etc. Features continuous frequency coverage from 2 mc to 250 mc, with a complete set of prewound coils, and a 500 ua panel meter. Front panel has a sensitivity control for the meter, and a phone jack for listening to the "zero-beat." Will also double as an absorption-type wave meter. Shpg. Wt. 4 lbs.

Low Frequency Coil Kit: Two extra plug-in coils to extend frequency coverage down to 350 kc. Shpg. Wt. 1 lb. No. 341-A. $3.00

MODEL GD-18
$19.95

HEATHKIT ALL-BAND COMMUNICATIONS-TYPE RECEIVER KIT

This communications-receiver covers 550 kc to 30 mc in four bands, and provides good sensitivity, selectivity, and fine image rejection. Ham bands are clearly marked on an illuminated dial scale. Features a transformer-type power supply—electrical band spread—antenna trimmer—headphone jack—automatic gain control and beat frequency oscillator. Accessory sockets are provided on the rear of the chassis for using the Heathkit model QF-1, Q Multiplier. Accessory socket is handy, also, for operating other devices that require plate and filament potentials. Will supply +250 VDC at 15 ma and 12.6 VAC at 300 ma. Ideal for the beginning ham or short wave listener. Shpg. Wt. 12 lbs.

Cabinet: Fabric covered cabinet with aluminum panel as shown. Part no. 91-15A. Shpg. Wt. 5 lbs. $4.95.

MODEL AR-3
$29.95
(Less cabinet)

Heathkits...

By DAYSTROM

are outstanding in performance and dollar value

HEATHKIT ELECTRONIC IGNITION ANALYZER KIT

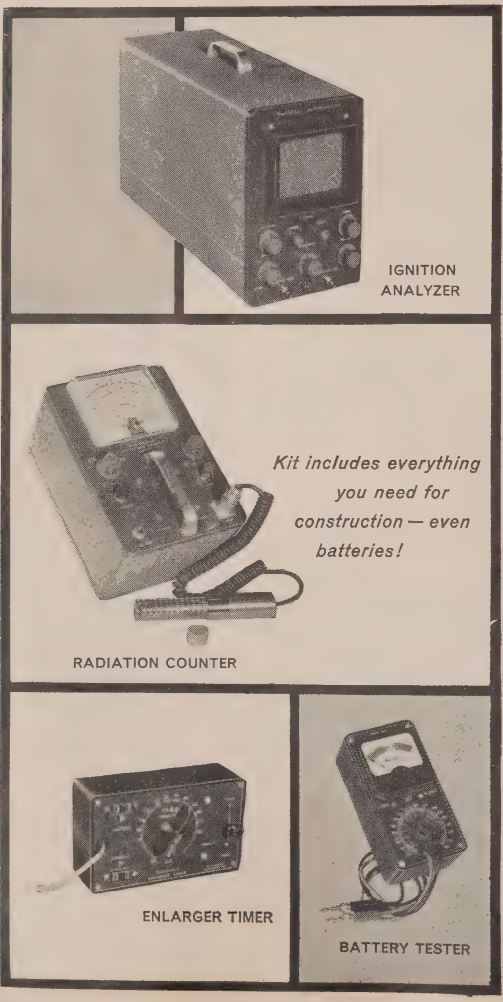
Previous electronic experience is not necessary to build this fine ignition analyzer. The construction manual supplied has complete step-by-step instructions plus large pictorial diagrams showing the exact placement and value of each component. All parts are clearly marked so that they are easily identified. The IA-1 is an ideal tool for engine mechanics, tune-up men, and auto hobbyists, since it traces the dynamic action of voltage in an ignition system on a cathode-ray tube screen. The wave form produced is affected by the condition of the coil, condenser, points, plugs, and ignition wiring, so it can be analyzed, and used as a "sign-post" to ignition system performance. This analyzer will detect inequality of spark intensity, a poor spark plug, defective plug wiring, breaker-point bounce, an open condenser, and allow setting of dwell-time percentage for the points. An important feature of this instrument is its ability to check dynamic performance, with the engine in operation (400 to 5000 RPM). It will show the complete engine cycle, or only one complete cylinder. Can be used on all types of internal combustion engines where breaker-points are accessible. Use it on automobiles, boats, aircraft engines, etc. Shpg. Wt. 18 lbs.

MODEL IA-1
$59.95

HEATHKIT PROFESSIONAL RADIATION COUNTER KIT

This Heathkit professional-type radiation counter is simple to build successfully, even if you have never built a kit before. Complete step-by-step instructions are combined with giant-size pictorial diagrams for easy assembly. By "building it yourself" you can have a modern-design, professional radiation counter priced far below comparable units. Provides high sensitivity with ranges from 0-100, 600, 6000 and 60,000 counts-per-minute, and 0-.02, .1, 1 and 10 miliroentgens-per-hour. Employs 900-volt bismuth tube in beta/gamma sensitive probe. Probe and 8-foot expandable cable included in kit price, as is a radiation sample for calibration. Use it in medical laboratories, or as a prospecting tool, and for civil defense to detect radioactive fallout, or other unknown radiation levels. Features a selectable time constant. Meter calibrated in CPM or mR/hour in addition to "beep" or "click" from panel-mounted speaker. Prebuilt "packaged" high voltage power supply with reserve capacity above 900 volt level at which it is regulated. Merely changing regulator tube type would allow use of scintillation probe if desired. Employs five tubes (plus a transistor) to insure stable and reliable operation. Kit price includes batteries. Shpg. Wt. 8 lbs.

MODEL RC-1
$79.95



IGNITION ANALYZER

Kit includes everything you need for construction — even batteries!

RADIATION COUNTER

ENLARGER TIMER

BATTERY TESTER

Heathkits...

By DAYSTROM

are supplied with comprehensive instructions that eliminate costly mistakes and save valuable time

HEATHKIT ENLARGER TIMER KIT

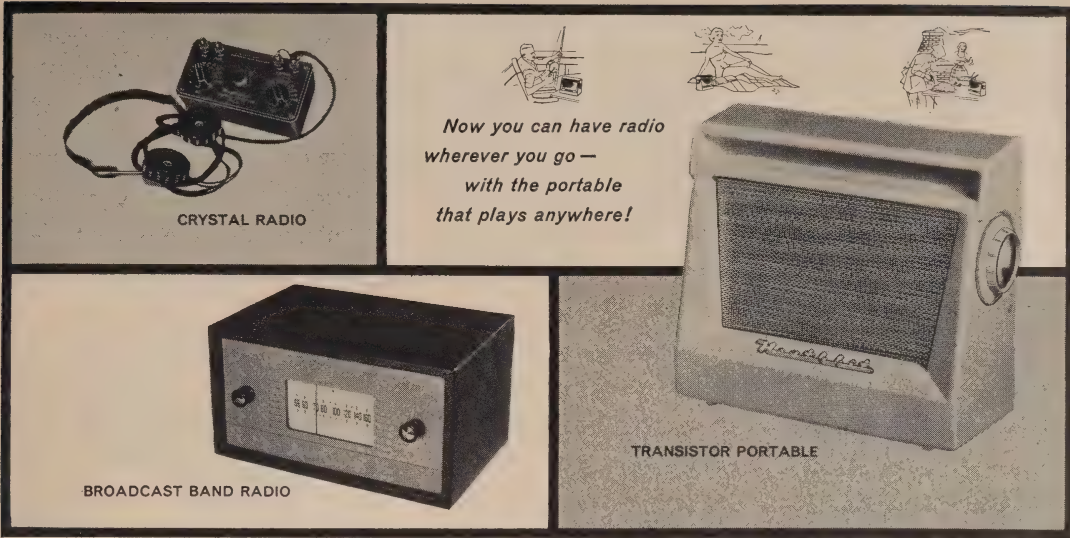
The ET-1 is an easy-to-build electronic device to be used by amateur or professional photographers in timing enlarger operations. The calibrated dial on the timer covers 0 to 1 minute, calibrated in 5-second gradations. The continuously variable control allows setting of the "on" cycle of your enlarger, which is plugged into a receptacle on the front panel of the ET-1. A "safe light" can also be plugged in so that it is automatically turned "on" when the enlarger is turned "off." Handles up to 350 watts with built-in relay. All-electronic timing cycle insures maximum accuracy. Timer does not have to be reset after each cycle, merely flip lever switch to print, to repeat time cycle. A control is provided for initial calibration. Housed in a compact plastic case that will resist attack of photographic chemicals. A fine addition to any dark room. Shpg. Wt. 3 lbs.

MODEL ET-1
$11.50

HEATHKIT BATTERY TESTER KIT

The BT-1 is a special battery testing device that actually "loads" the battery under test (draws current from it) while it is being tested. Weak batteries often test "good" with an ordinary voltmeter but the built-in load resistance of the BT-1 automatically draws enough current from the battery to reveal its true condition. Simple to operate with "good-weak-replace" scale. Tests all kinds of dry cell batteries within ranges of 0-15 volts and 0-180 volts. Slide switch provides for either 10 ma or 100 ma load, depending on whether you're testing an A or B battery. Not only determines when battery is completely exhausted, but makes it possible to anticipate failure by noting weak condition. Ideal for testing dry cell hearing aid, flashlight, portable radio, and model airplane batteries. Test batteries in a way your customers can understand and stimulate battery sales. Shpg. Wt. 2 lbs.

MODEL BT-1
$8.50



HEATHKIT CRYSTAL RADIO KIT

The Heathkit model CR-1 crystal radio is similar to the "crystal sets" of the early radio days except that it has been improved by the use of sealed germanium diodes and efficient "high-Q" coils. The sealed diodes eliminate the critical "cats whisker" adjustment, and the ferrite coils are much more efficient for greater signal strength. Housed in a compact plastic box, the CR-1 uses two tuned circuits, each with a variable tuning capacitor, to select the local station. It covers the broadcast band from 540 to 1600 kc. Requires no external power whatsoever. This receiver could prove valuable to emergency reception of civil defense signals should there be a power failure. The low kit price even includes headphones. Complete step-by-step instructions and large pictorial diagrams are supplied for easy assembly. The instruction manual also provides the builder with the basic fundamentals of signal reception so that he understands how the crystal receiver functions. An interesting and valuable "do-it-yourself" project for all ages. Shpg. Wt. 3 lbs.

MODEL CR-1
$7.95

Heathkits...

By DAYSTROM

are easy and fun to build,
and they let you learn
by "doing-it-yourself"

HEATHKIT TRANSISTOR PORTABLE RADIO KIT

Heath engineers set out to develop a "universal" AM radio, suitable for use anywhere. Their objective was a portable that would be as much "at home" inside as it is outside, and would feature top quality components for high performance and long service life. The model XR-1 is the result of these efforts. Six name-brand (Texas Instrument) transistors were selected for extra good sensitivity and selectivity. A 4" by 6" PM speaker with heavy magnet was chosen to insure fine tone quality. The power supply was designed to use six standard size "D" flashlight cells because they are readily available, inexpensive, and because they afford extremely long battery life (between 500 and 1000 hours). Costs you no more to operate from batteries than what you pay for operating a small table-model radio from the power line. An unbreakable molded plastic was selected for cabinet material because of its durability and striking beauty. Circuit is compact and efficient, yet components are not excessively crowded. Transformers are prealigned so it is ready for service as soon as construction is completed. Has built in rod-type antenna for reception in all locations. Cabinet dimensions are 9" L x 8" H x 3¾" D. Comes in holiday gray, with gold-anodized metal speaker grille. Compare this portable, feature by feature, to all others on the market, and you'll appreciate what a tremendous dollar value it represents! Shpg. Wt. 4 lbs.

MODEL XR-1
$34.95
(Less batteries)
(With cabinet)

HEATHKIT BROADCAST BAND RADIO KIT

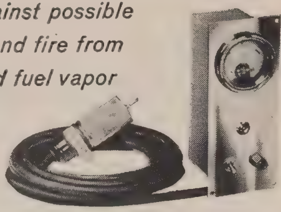
This table-model broadcast radio is fun to build, and is a fine little receiver for your home. It covers the standard broadcast band from 550 to 1600 kc with good sensitivity and selectivity. The 5½" PM speaker provides surprisingly good tone quality. High-gain IF transformers, miniature tubes, and a rod-type built in antenna, assure good reception in all locations. The power supply is transformer operated, as opposed to many of the economy "AC-DC" types. It's easy to build from the step-by-step instructions, and the construction manual includes information on operational theory, for educational purposes. Your success is assured by completely detailed information which also explains resistor and capacitor color codes, soldering techniques, use of tools, etc. A signal generator is recommended for final alignment. Shpg. Wt. 10 lbs.

Cabinet: Fabric covered cabinet with aluminum panel as shown. Shpg. Wt. 5 lbs. Part no. 91-9A. $4.95.

MODEL BR-2
$18.95
(Less cabinet)

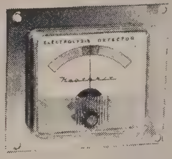
HEATH COMPANY *A Subsidiary of Daystrom, Inc.* **BENTON HARBOR 20, MICH.**

protects against possible explosion and fire from undetected fuel vapor

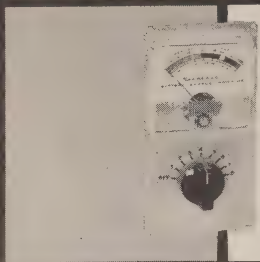


FUEL VAPOR DETECTOR

detects electrolysis currents which cause deterioration of underwater metal fittings on your boat

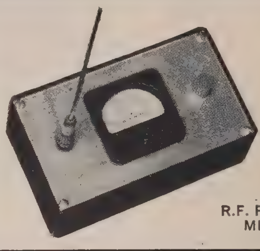


ELECTROLYSIS DETECTOR



indicates condition and charge of batteries for safe cruising

BATTERY CHARGE INDICATOR



R.F. POWER METER

HEATHKIT FUEL VAPOR DETECTOR KIT

Protect your boat and its passengers against fire or explosion from undetected fuel vapor by building and using one of these fine units. The Heathkit Fuel Vapor Detector indicates the presence of fumes on a three-color "safe-dangerous" meter scale and immediately shows if it is safe to start the engine. A pilot light on the front panel shows when the detector is operating, and it can be left on continuously, or just used intermittently. A panel control enables initial calibration of the detector when installed. Features a hermetically-sealed meter with chrome bezel, and a chrome-plated brass panel. It is very simple to build and install, even by one not having previous experience. Models FD-1-6 (6 volts DC) and FD-1-12 (12 volts DC) operate from your boat batteries. The kit is complete in every detail, even to the inclusion of a spare detector unit. Shpg. Wt. 4 lbs.

6 volt MODEL FD-1-6
12 volt MODEL FD-1-12
$35.95 EACH

HEATHKIT BATTERY CHARGE INDICATOR KIT

The Heathkit model CI-1 Marine Battery Charge Indicator has been designed especially for the boat owner, although it has found use in service stations, power stations, and radio stations where banks of batteries are kept in reserve for emergency power. It is intended to replace the hydrometer method of checking storage batteries, and to eliminate the necessity for working with acid in small, below-decks enclosures. Now it is possible to check as few as one, or as many as eight storage batteries, merely by turning the switch and watching the meter. A glance at the meter tells you instantly whether your batteries are sufficiently charged for safe cruising. Dimensions are 2-7/8" W x 5-11/16" H x 2" D. Operates on either 6 or 12 volt systems using lead-acid batteries, regardless of size. Simple installation can be accomplished by the boat owner in fifteen minutes. Shpg. Wt. 3 lbs.

MODEL CI-1
$16.95

HEATHKIT ELECTROLYSIS DETECTOR KIT

The Heathkit model ED-1 Electrolysis Detector indicates the extent of electrolysis currents between the boat's common ground and underwater fittings, except on boats having metal hulls. These currents, undetected, could cause gradual corrosion and deterioration of the propeller or other metal fittings below the water line. It is particularly helpful when installing electrical equipment of any kind, or to determine proper polarity when power is obtained from a shore supply. Easy-to-build, the model ED-1 consists of a hermetically-sealed, waterproof meter, special sensing plate, and sufficient wire to install, including the necessary hardware. Mounts on instrument panel where it can be easily seen. Requires no power for operation, and gives instant warning to guard your boat for a lifetime. Shpg. Wt. 2 lbs.

MODEL ED-1
$9.95

HEATHKIT RF POWER METER KIT

The Heathkit RF Power Meter Kit is designed to sample the RF field in the vicinity of your transmitter, whether it be marine, mobile, or fixed. Output meter is merely placed in some location close to the transmitter, to pick up RF radiation from the antenna. Requires no batteries, electricity, nor direct connection to the transmitter. It provides you with a continuing indication of transmitter operation. You can easily detect if power is dropping off by comparing present meter readings with past ones. Operates with any transmitter having output frequencies between 100 kc and 250 mc, regardless of power. Sensitivity is 0.3 volts RMS full scale, and a special control on the panel allows for further adjustment of the sensitivity. Meter is a 200 ua unit, mounted on a chrome-plated brass panel. The entire PM-1 measures only 3¾" W x 6¼" L x 2" D. An easy way to put your mind at ease concerning transmitter operation. Shpg. Wt. 2 lbs.

MODEL PM-1
$14.95

Heathkits...

By DAYSTROM

now offer you completely modern marine equipment with outstanding design features

HEATHKIT TRANSISTOR RADIO DIRECTION FINDER KIT

The Heathkit Transistor Radio Direction Finder model DF-1 is a self-contained, self-powered, 6-transistor super heterodyne broadcast radio receiver incorporating a directional loop antenna, indicating meter, and integral speaker. It is designed to serve primarily as an aid to navigation when out of sight of familiar landmarks. It can be used not only aboard yachts, fishing craft, tugs, and other vessels which navigate either out of sight of land or at night, but also for the hunter, hiker, camper, fisherman, aviator, etc. It is powered by a 9-volt battery. (A spare battery is also included with the kit). The frequency range covers the broadcast band from 540 to 1600 kc and will double as a portable radio. A directional high-Q ferrite antenna is incorporated which is rotated from the front panel to obtain a fix on a station and a 1 ma meter serves as the null and tuning indicator. The controls consist of: tuning, volume and power (on-off), sensitivity, heading indicator (compass rose) and bearing indicator (antenna index). Overall dimensions are 7½" W x 5⅞" H x 5⅜" D. Supplied with slip-in-place mounting brackets, which allow easy removal from ship bulkheads or other similar places. Shpg. Wt. 5 lbs.

MODEL DF-1

$49.95

(Available after November 15)

use it for a radio-compass or as a portable radio

TRANSISTOR RADIO DIRECTION FINDER

Heathkits...

By DAYSTROM

are sold only by direct mail, passing middleman profits on to you

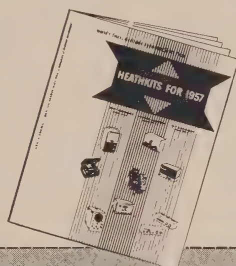
Pioneer in "do-it-yourself" electronics

HOW CAN YOU MISS?

The Heath Company maintains a technical consultation service, should you experience some sort of difficulty in construction or operation. Although only a very small percentage of our customers ever have occasion to use this service (usually only beginners in electronics) it is still reassuring to know that technical help is available when needed. A service department is also available, should you wish a complete factory check of operation and alignment or repair. After you build your first Heathkit you'll realize how easy it is.

Free Catalog

Send for this informative booklet listing more than 100 "do-it-yourself" kits.



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(Continued from page 61)

red and green phasing coils," Fuzzball hazarded.

"That's the general idea," Red replied. "We're through with the blue phasing coil for the time being, so we turn the blue amplitude control to zero."

Fuzzball's eyes lit up brightly. "So then we would turn up the red amplitude control, and resonate the red phasing coil for a peak?"

"Don't stop now, man."

"And then we would turn the red amplitude control to zero?"

"Keep with it," Red encouraged.

"And then turn up the green amplitude control, and resonate the green phasing coil for a peak?"

"Yes, and . . ."

"And finally turn down the green amplitude control to zero." Fuzzball finished triumphantly.

Red slapped Fuzz enthusiastically on the back. "I don't know how you do it," he said admiringly.

"You really want to know how he does it?" Bess asked out of the corner of her mouth.

Fuzzball's face clouded and his lip curled.

Red clapped his hand quick over Fuzzball's mouth. "Uh, uh!" he warned, "make sure brain is in gear before putting mouth in motion," he suggested.

"OK, OK," said Fuzzball, "I'll pretend I didn't hear that one, either."

"As before being so rudely interrupted," Red continued, "you then adjust the horizontal amplitude control to get a good straight line of blue dots." (Fig. 1-b.)

"I guess you pay attention only to the horizontal center row of dots," Fuzz suggested.

"You got a mind like an elephant," Red remarked. "You remembered from the vertical, didn't you?"

"Shucks, it ain't nothing," replied Fuzzball modestly. "What next?"

"Next you straighten the lines of green and red dots with the amplitude controls, and touch up the beam magnets."

"And then you have the horizontal converged," Fuzzball concluded.

"Not unless you have beginner's luck—*you* would, I suppose," Red replied. "No, you'll find you can't straighten the lines or dots completely with the amplitude controls. You go back and touch up the phase controls a bit."

"When do you stop all this back-and-forth?" demanded Fuzzball.

"There's a rule-of-thumb," Red replied. "If you can stand back 4 feet from the screen and *honestly* see no misconvergence, you can consider that you have done a job of work."

"By some strange coincidence, might you have another photo which you have tore out of R-E and showing this desirable situation?" asked Fuzzball softly.

"Put *that* in your pipe and smoke it," Red suggested, showing him Fig. 2.

"Yop, I see what you mean," mused

TELEVISION

Fuzz. "Tell me, do you like dots or lines better for this little routine?"

"Well, now—that depends," Red replied. "When you're getting the parallel lineups, there's no question but what lines are easier to work with and less confusing than a series of broken dots. But then, on the other hand, when you are getting down to the final convergence, there's nothing like the little dots to show you that maybe you aren't quite as smart as your mother thinks you are."

"Would you maybe by some strange . . ."

"So put that in your pipe too. Have a *good* smoke," suggested Red. (Fig. 3).

"Yeah, I see what you mean," said Fuzz. "The crosshatch pattern doesn't show up this misconvergence nearly as plain as the little dots."

"You can just see the wheels turning in his busy little mind," Bess remarked.

Red spoke up quickly. "They say that grass doesn't grow on a busy street, but Fuzzball is the exception that proves the rule. Here's a buck, Fuzz—go get a haircut—I'll pay for it."

"Better give him four bucks," suggested Bess, "so he can get all four corners trimmed."

Red clapped his hand over Fuzz' half-opened mouth. "Get going," he suggested. END

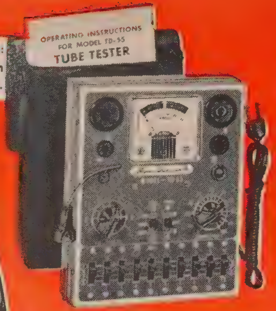
HOT COIL

I was called upon to service a new television receiver, just delivered, the complaint being no sound and no pix after 5 minutes. I changed all tubes that might cause the trouble but the receiver still cut out after 5 minutes. As the customer did not want the chassis pulled, leaving them without television over the week end, they decided to have it taken to the shop the following Monday and take a chance that it might give them some use by turning it off and on at intervals.

I called back the following Monday and at the door the customer greeted me with the fact that he had managed to get the receiver working continuously. I found a fan underneath it which sent cool air into the bottom of the chassis through the wire mesh covering the vent hole in the base of the cabinet, a console model. This ingenious remedy had suggested itself to this customer when I said that it cut out after it warmed up.

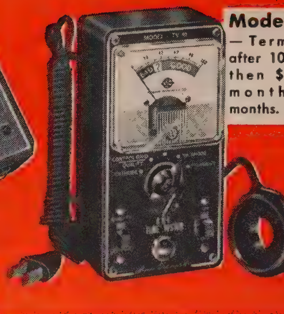
Pulling the chassis, the faulty component was found to be the first peaking coil following the video detector in this intercarrier receiver. This coil was wound on a resistor but one end of the coil wire had not been soldered to the resistor lead. As it was loosely wound, 5 minutes of heat from the chassis made it expand sufficiently to open the circuit feeding the video amplifier and the sound if strip. The blast of cool air had prevented this component from absorbing any heat and had allowed the set to function normally.—*G. N. Carter*

Model TW-11 — Terms: $11.50 after 10 day trial then $6.00 per month for 6 months.



Model TD-55 — Terms: $6.95 after 10 day trial then $5.00 per month for 4 months.

Model TV-12 — Terms: $22.50 after 10 day trial then $10.00 per month for 5 months.



Model TV-40 — Terms: $3.85 after 10 day trial then $4.00 per month for 3 months.

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Superior's New Model TD-55

EMISSION TYPE TUBE TESTER

FOR
- **The Experimenter or Part-time Serviceman**, who has delayed purchasing a higher priced Tube Tester.
- **The Professional Serviceman**, who needs an extra Tube Tester for outside calls.
- **The busy TV Service Organization**, which needs extra Tube Testers for its field men.

Speedy, yet efficient operation is accomplished by:

1. Simplification of all switching and controls.
2. Elimination of old style sockets used for testing obsolete tubes (26, 27, 57, 59, etc.) and providing sockets and circuits for efficiently testing the new Noval and Sub-Minar types.

You can't insert a tube in wrong socket. It is impossible to insert the tube in the wrong socket when using the new Model TD-55. Separate sockets are used, one for each type of tube base. If the tube fits in the socket it can be tested.

"Free-point" element switching system. The Model TD-55 incorporates a newly designed element selector switch system which reduces the possibility of obsolescence to an absolute minimum. Any pin may be used as a filament pin and the voltage applied between that pin and any other pin or even the "top-cap."

Checks for shorts and leakages between all elements. The Model TD-55 provides a super sensitive method of checking for shorts and leakages up to 5 Megohms between any and all of the terminals. Continuity between various sections is individually indicated. This is important, especially in the case of an element terminating at more than one pin. In such cases the element or internal connection often completes a circuit.

Elemental switches are numbered in strict accordance with R.M.A. specification. One of the most important improvements, we believe, is the fact that the 4 position fast-action snap switches are all numbered in exact accordance with the standard R.M.A. numbering system. Thus, if the element terminating in pin No. 7 of a tube is under test, button No. 7 is used for that test.

Complete with carrying case............ **$26.95 NET**

Superior's New Model TV-40

PICTURE TUBE TESTER

Not a Gadget—Not a Make-Shift Adapter, but a Wired Picture Tube Tester With a Meter for Measuring Degree of Emission—at Only $15.85

Of course you can buy an adapter for about $5—which theoretically will convert your standard tube tester into a picture-tube tester; or a neon type instrument which sells for a little more and is supposed to be "as good as" a metered instrument. Superior does not make nor do they recommend use of C.R.T. adapters or neon gadgets because a Cathode Ray Tube is a very complex device, and to properly test it, you need an instrument designed exclusively to test C. R. Tubes and nothing else.

Tests ALL magnetically deflected tubes . . . in the set . . . out of the set . . . in the carton!

- Tests all magnetically deflected picture tubes from 7 inch to 30 inch types.
- Tests for quality by the well established emission method. All readings on "Good-Bad" scale.
- Tests for inter-element shorts and leakages up to 5 megohms.
- Test for open elements.

EASY TO USE: Simply insert line cord into any 110 volt A.C. outlet, then attach tester socket to tube base (ion trap need not be on tube). Throw switch up for quality test . . . read direct on Good-Bad scale. Throw switch down for all leakage tests.

Only............ **$15.85 NET**

Superior's New Model TV-12

TRANS-CONDUCTANCE TUBE TESTER

TESTING TUBES

- **Employs improved TRANS-CONDUCTANCE circuit.** An in-phase signal is impressed on the input section of a tube and the resultant plate current change is measured. This provides the most suitable method of simulating the manner in which tubes actually operate in Radio & TV receivers, amplifiers and other circuits. Amplification factor, plate resistance and cathode emission are all correlated in one meter reading.
- **NEW LINE VOLTAGE ADJUSTING SYSTEM.** A tapped transformer makes it possible to compensate for line voltage variations to a tolerance of better than 2%.
- **SAFETY BUTTON**—protects both the tube under test and the instrument meter against damage due to overload or other form of improper switching.
- **NEWLY DESIGNED FIVE POSITION LEVER SWITCH ASSEMBLY.** Permits application of separate voltages as required for both plate and grid of tube under test, resulting in improved Trans-Conductance circuit.

Extra Feature

Model TV-12 Also Tests Transistors!

A transistor can be safely and adequately tested only under dynamic conditions. The Model TV-12 will test all transistors in that approved manner, and quality is read directly on a special "transistor only" meter scale.

The Model TV-12 will accommodate all transistors including NPN's, PNP's Photo and Tetrodes, whether made of Germanium or Silicon, either point contact or junction contact types.

Housed in hand-rubbed oak cabinet............ **$72.50 NET**

Superior's New Model TW-11

STANDARD PROFESSIONAL TUBE TESTER

- Tests all tubes, including 4, 5, 6, 7, Octal, Lockin, Hearing Aid, Thyratron, Miniatures, Sub-miniatures, Novals, Sub-minars, Proximity fuse types, etc.
- Uses the new self-cleaning Lever Action Switches for individual element testing. Because **all elements are numbered according to pin-number in the RMA base numbering system**, the user can instantly identify which element is under test. Tubes having tapped filaments and tubes with filaments terminating in more than one pin are truly tested with the Model TW-11 as any of the pins may be placed in the neutral position when necessary.
- The Model TW-11 does not use any combination type sockets. Instead individual sockets are used for each type of tube. Thus **it is impossible to damage a tube by inserting it in the wrong socket.**
- Free-moving built-in roll chart provides complete data for all tubes. All tube listings printed in large easy-to-read type.

NOISE TEST: Phono-jack on front panel for plugging in either phones or external amplifier will detect microphonic tubes or noise due to faulty elements and loose internal connections.

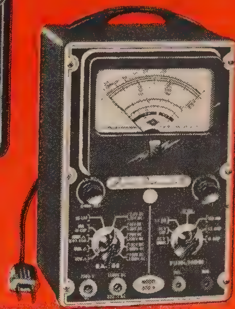
EXTRAORDINARY FEATURE: SEPARATE SCALE FOR LOW-CURRENT TUBES. Previously, on emission-type tube testers, it has been standard practice to use one scale for all tubes. As a result, the calibration for low-current types has been restricted to a small portion of the scale. The extra scale used here greatly simplifies testing of low-current types. ***Housed in hand-rubbed oak cabinet***............ **$47.50 NET**

USE APPROVAL FORM ON NEXT PAGE

Model TV-50 — Terms: $11.50 after 10 day trial then $6.00 per month for 6 months.

Model 76—Terms: $6.95 after 10 day trial then $5.00 per month for 4 months.

Model 770-A — Terms: $3.85 after 10 day trial then $4.00 per month for 3 months.



Model 670-A — Terms: $7.40 after 10 day trial then $3.50 per month for 6 months.

TRY FOR 10 DAYS

before you buy! **then** if satisfactory pay in easy, interest free, monthly payments. See coupon below.

Superior's New Model TV-50 GENOMETER

7 Signal Generators in One!

- R.F. Signal Generator for A.M.
- R.F. Signal Generator for F.M.
- Audio Frequency Generator
- Bar Generator
- Cross Hatch Generator
- Color Dot Pattern Generator
- Marker Generator

R. F. SIGNAL GENERATOR: 100 Kilocycles to 60 Megacycles on fundamentals and from 60 Megacycles to 180 Megacycles on powerful harmonics.

VARIABLE AUDIO FREQUENCY GENERATOR: Provides a variable 300 cycle to 20,000 cycle peaked wave audio signal.

BAR GENERATOR: Pattern consists of 4 to 16 horizontal bars or 7 to 20 vertical bars.

CROSS HATCH GENERATOR: Pattern consists of non-shifting horizontal and vertical lines interlaced to provide a stable cross-hatch effect.

DOT PATTERN GENERATOR (FOR COLOR TV): The Dot Pattern projected on any color TV Receiver tube by the Model TV-50 will enable you to adjust for proper color convergence.

MARKER GENERATOR: The following markers are provided: 189 Kc., 262.5 Kc., 456 Kc., 600 Kc., 1000 Kc., 1400 Kc., 1600 Kc., 2000 Kc., 2500 Kc., 3579 Kc., 4.5 Mc., 5 Mc., 10.7 Mc., (3579 Kc. is the color burst frequency.)

Complete with shielded leads .... **$47.50 NET**

Superior's New Model 76

- IT'S A CONDENSER BRIDGE
- IT'S A RESISTANCE BRIDGE
- IT'S A SIGNAL TRACER
- IT'S A TV ANTENNA TESTER

SPECIFICATIONS

CAPACITY BRIDGE SECTION 4 Ranges: .00001 Microfarad to .005 Microfarad; .001 Microfarad to .5 Microfarad; .1 Microfarad to 50 Microfarads; 20 Microfarads to 1000 Microfarads. Will also measure the power factor of all condensers from .1 to 1000 Microfarads.

RESISTANCE BRIDGE SECTION 2 Ranges: 100 ohms to 50,000 ohms; 10,000 ohms to 5 megohms.

SIGNAL TRACER SECTION With the use of the R.F. and A.F. Probes included with the Model 76, you can make stage gain measurements, locate signal loss in R.F. and Audio stages, localize faulty stages, locate distortion and hum, etc.

TV ANTENNA TESTER SECTION Loss of sync., snow and instability are only a few of the faults which may be due to a break in the antenna, so why not check the TV antenna first? Locates a break in any TV antenna and measures the location of the break in feet from the set terminals.

Complete with R.F. and A.F. probes and test leads .... **$26.95 NET**

Superior's New Model 670-A SUPER-METER

A Combination VOLT-OHM MILLIAMMETER *PLUS* Capacity, Reactance, Inductance and Decibel Measurements.

ADDED FEATURE: Built in ISOLATION TRANSFORMER reduces possibility of burning out meter through misuse.

SPECIFICATIONS:

D.C. VOLTS: 0 to 7.5/15/75/150/750/1,500/7,500 Volts
A.C. VOLTS: 0 to 15/30/150/300/1,500/3,000 Volts
OUTPUT VOLTS: 0 to 15/30/150/300/1,500/3,000 Volts
D.C. CURRENT: 0 to 1.5/15/150 Ma. 0 to 1.5/15 Amperes
RESISTANCE: 0 to 1,000/100,000 Ohms 0 to 10 Megohms
CAPACITY: .001 to 1 Mfd. 1 to 50 Mfd. (Good-Bad scale for checking quality of electrolytic condensers.)
REACTANCE: 50 to 2,500 Ohms 2,500 Ohms to 2.5 Megohms
INDUCTANCE: .15 to 7 Henries 7 to 7,000 Henries
DECIBELS: −6 to +18 +14 to +38 +34 to +58

Complete with test leads .... **$28.40 NET**

Superior's New Model 770-A POCKET-SIZED VOLT-OHM MILLIAMMETER

• USING THE NEW "FULL-VIEW" METER 71% MORE SCALE AREA—Occupies exactly the same space used by the older standard 2½" Meters, yet provides 71% more scale area. As a result, all calibrations are printed in large easy-to-read type and for the first time it is now possible to obtain *measurements instead of approximations.*

• Compact—measures 3⅛" x 5⅞" x 2¼". • Uses "Full View" 2% accurate, 850 Microampere D'Arsonval type meter. • Housed in round-cornered, molded case. • Beautiful black etched panel.

Specifications: 6 A.C. VOLTAGE RANGES: 0-15/30/150/300/1500/3000 Volts. 6 D.C. VOLTAGE RANGES: 0-7.5/15/75/150/750/1500 Volts. 2 RESISTANCE RANGES: 0-10,000 Ohms, 0-1 Megohm. 3 D.C. CURRENT RANGES: 0.15/150 Ma., 0-1.5 Amps. 3 DECIBEL RANGES: −6 db to + 18 db, + 14 db to + 38 db, + 34 db to + 58 db.

Complete with test leads .... **$15.85 NET**

We invite you to try before you buy any of the models described on this and the preceding page. If after a 10 day trial you are completely satisfied and decide to keep the Tester, you need send us only the down payment and agree to pay the balance due at the monthly indicated rate.

NO INTEREST OR FINANCE CHARGES ADDED!

If not completely satisfied, you are privileged to return the Tester to us, cancelling any further obligation.

MOSS ELECTRONIC DISTRIBUTING CO., INC.
Dept. D-401, 3849 Tenth Ave., New York 34, N. Y.

Please send me the units checked. I agree to pay down payment within 10 days and to pay the monthly balance as shown. It is understood there will be no finance or interest charges added. It is further understood that should I fail to make payment when due, the full unpaid balance shall become immediately due and payable.

Name ....

Address ....

City .... Zone .... State ....

All Prices net. F.O.B. N.Y.C.

- ☐ Model TW-11 .... Total Price $47.50 $11.50 within 10 days. Balance $6.00 monthly for 6 months.
- ☐ Model 76 .... Total Price $26.95 $6.95 within 10 days. Balance $5.00 monthly for 4 months.
- ☐ Model TD-55 .... Total Price $26.95 $6.95 within 10 days. Balance $5.00 monthly for 4 months.
- ☐ Model TV-50 .... Total Price $47.50 $11.50 within 10 days. Balance $6.00 monthly for 6 months.
- ☐ Model TV-40 .... Total Price $15.85 $3.85 within 10 days. Balance $4.00 monthly for 3 months.
- ☐ Model 670-A .... Total Price $28.40 $7.40 within 10 days. Balance $3.50 monthly for 6 months.
- ☐ Model 770-A .... Total Price $15.85 $3.85 within 10 days. Balance $4.00 monthly for 3 months.
- ☐ Model TV-12 .... Total Price $72.50 $22.50 within 10 days. Balance $10.00 monthly for 5 months.

TELEVISION

POSITIVE GRID

The complaint on a Zenith ZOJ22 was one of horizontal frequency drift after the receiver had been on for about 2 hours. At this time the horizontal hold also became very sensitive.

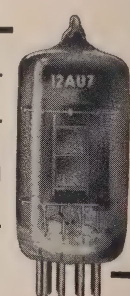
After checking the horizontal oscillator, horizontal frequency control, and horizontal phase detector tubes, the set was checked for defective components in these same circuits, all without finding the trouble.

Checking further, approximately 1 volt positive was found on the grid of the afc tube (½ 6SN7). The plate voltage was below normal also. When the tube was pulled out of the socket, the voltage on the grid went up to 20. Taking one part out of the circuit at a time, the voltage was found to be coming from two 100,000-ohm resistors in series, feeding the grid of the afc tube. When all parts were taken off both ends of the resistors, the voltage was still present. One of the resistors was tied between vacant pins 2 and 6 of the 6W4 tube, and the voltage was coming from pin 2. The socket was checked, and then the tube. The culprit: the 6W4.

Checking the construction of the tube, I found pin 2 was used inside the tube as a support for the mica spacer and was located directly under the plate structure. My guess as to the trouble—leaky mica.

A new tube was inserted, and the set worked fine. But just in case the next tube gets the same trouble-making idea, that resistor is now located between two terminals of a nice healthy tie post.—*Robert A. Hillskemper*

DON'T LET THEM FOOL YOU



This tube may look like new, but it's substandard—masquerading as new and unused. For the past 23 months RADIO-ELECTRONICS has been conducting a campaign to combat this fraudulent practice. We have no objection to anyone selling or advertising used or substandard tubes—PROVIDED THEY ARE SO LABELED OR ADVERTISED. But we are old-fashioned enough to think that when you see a mail order ad which offers "guaranteed tubes" or even just "tubes," you should expect that the ad means brand-new, unused tubes, even if it doesn't specifically say so.

To be certain that RADIO-ELECTRONICS readers are not fooled, we do not accept advertising which tends to be misleading—but insist that ads specify exactly what the tubes are—new and unused, or used tubes, seconds, etc. This policy has been in effect since our January 1956 issue.

7-TRANSISTOR POCKET RADIO

Superhet design features push-pull output and slip-in-your-pocket size

By HOWARD GRANOFF

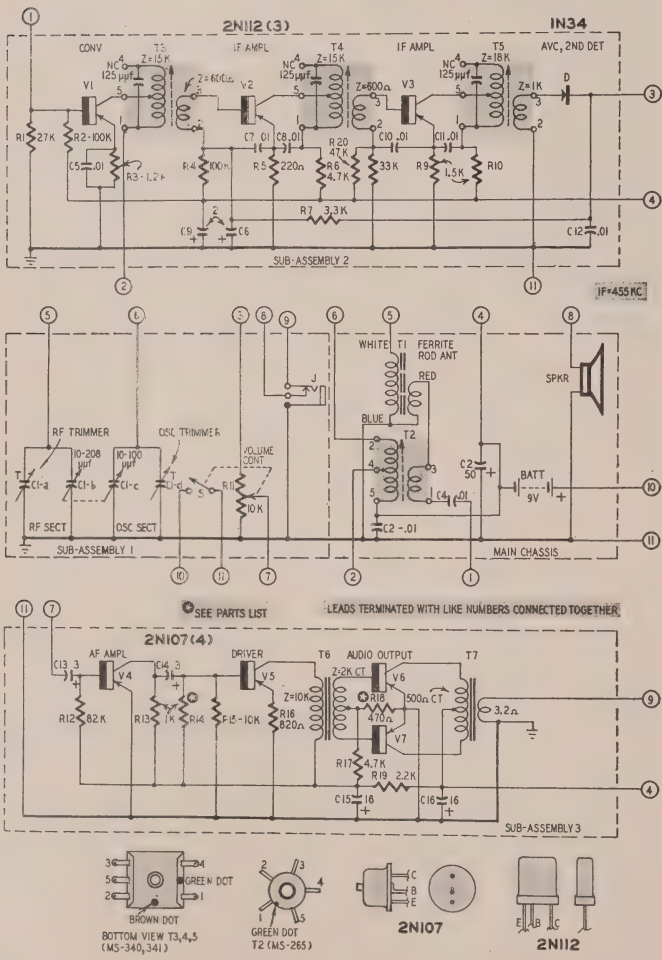


Fig. 1—Circuit of the receiver's four sections. Unmarked 33K resistor is R8 and the .01 capacitor C2 should be C3.

FOR many years I have followed the many articles on transistors and transistorized devices such as radio receivers. Many attempts have been made to reduce size while still preserving the desirable features found in commercial portables. Something usually has to be sacrificed.

My main goal was to include in one package all those features that are desirable in a portable radio receiver. The final result was a 4 x 3 x 1-inch receiver, with good operating economy, high sensitivity, sharp selectivity and more than enough power to drive a 2½-inch PM speaker.

The set is a complete superheterodyne containing seven transistors and one crystal diode (see Fig. 1). The total cost of the transistors and diode is about $13. Three of the transistors are 2N112's. One functions as a converter, the other two as if amplifiers. A 1N34 crystal diode operates as both avc and

(*Continued on page 93*)

R1—27,000 ohms
R2, 4—100,000 ohms
R3—1,200 ohms
R5—220 ohms
R6, 17—4,700 ohms
R7—3,300 ohms
R8—33,000 ohms
R9, 10—1,500 ohms
R11—pot, 10,000 ohms (Lafayette VC-28 or equivalent)
R12—82,000 ohms
R13—1,000 ohms
*R14—1,000 ohms
R15—10,000 ohms
R16—820 ohms
*R18—470 ohms
R19—2,200 ohms
R20—47,000 ohms
All resistors ¼ watt
C1—midget tuning capacitor; rf section, 10—208 μμf; oscillator section, 10—100 μμf (Lafayette MS270 or equivalent)
C2—50 μf, 12 volts, miniature electrolytic
C3, C4, C5, C7, C8, C10, C11, C12—.01 μf, miniature
C6, 9—2 μf, 12 volts, miniature electrolytics
C13, 14—3 μf, 12 volts, miniature electrolytics
C15, 16—16 μf, 12 volts, miniature electrolytics
D—1N34
J—closed-circuit phone jack, miniature (Lafayette MS-282 or equivalent)
S—spst, on R11
T1—Antenna coil for 540—1650 kc, matched to C1 (Lafayette MS—272 or equivalent)
T2—oscillator transformer, 455-kc if (Lafayette MS265 or equivalent)
T3, 4—if transformers; primary 15,000 ohms ct, secondary 600 ohms (Lafayette MS-340 or equivalent)
T5—if transformer; primary 18,000 ohms ct, secondary 1,000 ohms
T6—driver transformer; primary, 10,000 ohms; secondary 2,000 ohms ct (Argonne-109 or equivalent)
T7—output transformer; primary, 500 ohms CT; secondary, 3.2 ohms (Argonne AR-119 or equivalent)
V1, 2, 3—2N112
V4, 5, 6, 7—2N107
BATT, 9 volts, mercury (Mallory TR-146R or equivalent)
Speaker, 3.2-ohm voice coil, 2½ inches (Lafayette SK-65 or equivalent)
Bakelite sheet, 3¾ x 3 x 1/32 inches
Bakelite sheet, 3¼ x 1 x 1/32 inches
Bakelite sheet, 2¾ x 1 x 1/32 inches
Case, Lafayette 311 or equivalent
Transistor sockets (7)
Battery connectors
Sheet aluminum for bracket (Fig. 2-a) 2⅞ x 1½ inches
Earpiece
Knobs
Miscellaneous hardware

**These resistors worked well with the values shown; however, you may find it necessary to adjust these values to those that will work well with the transistors used.*

Build the Best— build ALLIED knight®-kits

the finest electronic equipment in money-saving kit form

LOWEST COST

ALLIED'S giant buying power passes biggest savings on to you—you do the easy assembly and your finished instrument equals the performance and appearance of equipment selling for several times the low KNIGHT-KIT cost. Your savings are BIG.

EASIEST TO BUILD

KNIGHT-KIT "Step-and-Check" instruction manuals with wall-sized picture diagrams are marvels of clarity—it's like having a good instructor at your side. No experience required—you can easily build any KNIGHT-KIT and get professional results.

LATEST DESIGN

Each ALLIED KNIGHT-KIT incorporates the very latest circuitry for top-quality performance. Tried and proved professional design and the use of premium quality parts throughout help insure your building success to bring you quality results.

knight-kits

COMPLETE KIT SELECTION:

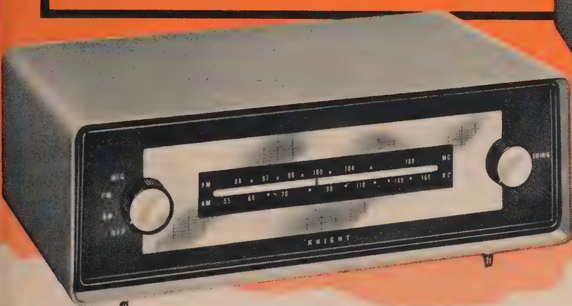
- HI-FI
- HOBBY
- INSTRUMENT
- AMATEUR

MONEYBACK GUARANTEE. When properly assembled, KNIGHT-KITS fully meet published specifications or we refund your money in full.

EASY TERMS. If your KNIGHT-KIT order comes to \$45.00 or more, you can make your purchase on our attractive Easy Payment Plan.

High Fidelity Everyone Can Afford

- World's Finest Hi-Fi Kits
- Custom-Styled
- Easiest to Build Hi-Fi
- Money-Saving



knight-kit High Fidelity FM-AM Tuner Kit

Model Y-787

\$49.95

Only \$4.99 down

- Latest Time-Saving Printed Circuit Design
- Flywheel Tuning
- Automatic Frequency Control
- 2.5 μv FM Sensitivity
- True High Fidelity Response
- Beautiful Custom-Styled "Space Saver" Case

The best-looking, best-performing FM-AM tuner kit your money can buy! Carefully designed for quick, easy construction—a tuner you'll enjoy assembling and be proud to own, both for its amazing musical performance and outstanding beauty. Covers the full AM broadcast band and 88 to 108 mc FM. On FM, *sensitivity is a remarkable 2.5 microvolts for 20 db of quieting;* hum and noise, –60 db; IF bandwidth, 200 kc at 50% down on curve; response, ± 0.5 db, 20-20,000 cps. On AM, *sensitivity is 3 microvolts for 10 db signal-to-noise ratio;* IF bandwidth, 8 kc at 50% down on curve; response, 20-8000 cps. Outstanding features include: Inertia Flywheel Tuning for effortless, accurate tuning; Automatic Frequency Control (plus AFC disabling) to "lock-in" FM stations; printed circuit board (with most of the kit wiring already done for you) assures time-saving, error-free assembly; pre-aligned RF and IF coils; tuned RF stage on FM; drift-compensated oscillator; neon glow tuning pointer; cathode follower output; two output jacks—one for recorder, one for amplifier; rotatable built-in ferrite antenna for AM. Includes beautiful French-gray case with chrome-finished tapered feet, 4 x 13 x 8″. Ideal for use with 18, 20 or 30 watt KNIGHT-KIT amplifiers. Ready for easy assembly. Shpg. wt., 12 lbs.

Model Y-787. FM-AM Tuner Kit. Net only............. **\$49.95**

knight-kit 18-Watt Complete Hi-Fi Amplifier Kit

Model Y-786

\$39.95

Only \$3.99 down

- The Last Word in Custom Hi-Fi Styling
- Full 18 Watts with Superb Hi-Fi Specifications
- 8 Inputs for Every Desired Signal Source
- Printed Circuit Switch and Printed Circuit Boards
- Full Equalization for All Record Types

Here is a custom-styled, easy-to-build complete Hi-Fi amplifier at a price that defies comparison. Delivers full 18 watts output with wide-range, flat frequency response for true hi-fi reproduction. Features 8 inputs for every possible signal source, including NARTB equalized tape head input. At full 18 watts output, distortion is only 0.5%; uses new RCA 6973 hi-fi output tubes. Frequency response is ± 1 db, 20-30,000 cps; tape head and magnetic cartridge sensitivity, 5 microvolts for 18 watts output; hum and noise level better than 60 db below 18 watts. Output taps for 4, 8 or 16 ohm speakers. Controls: Input and Record Equalization; Bass Boost and Attenuate; Treble Boost and Attenuate; Volume. Simplest assembly is made possible through the use of an exclusive printed circuit switch and two printed circuit boards—most of the kit wiring is already done for you. With custom-styled French-gray "space-saver" case on tapered feet finished in chrome, 4 x 13 x 8″. Complete with case, tubes, all parts, and step-by-step instructions, for easy, error-free assembly. Shpg. wt., 15 lbs.

Model Y-786. 18-Watt Hi-Fi Amplifier Kit. Net only...... **\$39.95**

EASY TERMS TO FIT YOUR BUDGET. ALLIED KNIGHT-KITS may be purchased under our Easy Payment Plan. Your order need total only \$45.00 or more—only 10% down, small monthly payments thereafter. No red tape—fast handling assured.

Our 37th Year

ORDER FROM **ALLIED RADIO** 100 N. WESTERN AVE. • CHICAGO 80, ILL.

Now you can have Custom-Styled Hi-Fi in ALLIED

knight-kit 30-Watt Complete Hi-Fi Amplifier Kit

Model Y-762
$76.95
Only $7.69 down

- Full Equalization, ±½ db of Recommended Accuracy
- Printed Circuit Switches • Printed Circuit Boards
- 8 Inputs For Every Possible Signal Source
- Full 30 Watts Output • Custom-Styled Beauty

Comparable to the best in Hi-Fi—at far less cost! Deluxe features include: Linear-deluxe Williamson-type circuit for flawless response; equalization for all records within ½ db of recommended accuracy; 2 exclusive new printed circuit switches in preamp section (no complex wiring to do); 3 printed circuit boards for time-saving, error-free assembly; separate, continuously variable Level and Loudness controls; use of premium 12AY7 tube for low noise and hum; DC on all filaments of preamp tubes; exclusive A-AB-B speaker selector switch (use speakers of mixed impedances without mismatch). 8 inputs: Tape Head direct; G.E. and Pickering cartridges; Ceramic cartridge; Microphone; Auxiliary; Tape Preamp; Tuner (with separate Level Set control). Power amplifier response, ± ½ db, 15-100,000 cps at full 30 watt level; distortion—harmonic, 0.55% at 30 watts—IM, 0.74% at 20 watts. Separate Bass and Treble controls; rumble filter switch; variable damping. Output, 8 and 16 ohms. With smart French-gray cabinet, 4 x 15 x 15″. Ready for easy, money-saving assembly. Shpg. wt., 32 lbs.

Model Y-762. 30-Watt Hi-Fi Amplifier Kit. Net only...... **$76.95**

knight-kit High Fidelity FM Tuner Kit

Model Y-751
$38.95
Only $3.89 down

- Authentic High Fidelity FM Response
- Flywheel Tuning • Automatic Frequency Control
- Printed Circuit • Pre-Adjusted Coils and IF's
- 4 Microvolt Sensitivity Guaranteed

Here is top value in creative engineering, impressive hi-fi performance and distinctive design—a tuner you'll be proud to build and own. Covers the full FM band, 88 to 108 mc. Features Automatic Frequency Control (with disabling feature) to "lock-in" stations and prevent drift; Inertia Flywheel Tuning for velvet-smooth, accurate station selection; pre-adjusted RF coils; pre-aligned IF's; cascode broad-band RF amplifier; drift-compensated oscillator; neon bulb pointer. All critical wiring is already done for you in the form of a printed circuit board—assembly is simple. Sensitivity is 4 microvolts for 20 db of quieting across entire band; output, 2 volts at 1000 microvolts input; IF bandwidth, 200 kc; response, 20-20,000 cps. with only 0.6% distortion. Output jacks for amplifier and tape recorder; cathode follower output. Ideal for use with the KNIGHT-KIT amplifiers, or any amplifier with phono-tuner switch. Features custom-styled case in French-gray, with tapered chrome-finished feet, 4 x 13 x 8″. Includes all parts, tubes and step-by-step instructions for easy assembly. Shpg. wt., 12 lbs.

Model Y-751. Hi-Fi FM Tuner Kit. Net only............ **$38.95**

knight-kit Deluxe 3-Way Speaker System Kit

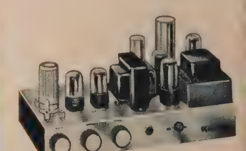
Model Y-937
$89.50
Only $8.95 down

- Pre-Finished "Quik-Craft" Corner Enclosure
- Klipsch Designed and Licensed
- Famous Knight 12″ 3-Way Speaker
- Easy to Assemble—Top Hi-Fi Quality
- Choice of Enclosure Finishes

3-Way Speaker

Deluxe quality high fidelity speaker system at a money-saving low price. Easy to assemble—all you need is a screwdriver. System includes KNIGHT "Quik-Craft" corner-type folded-horn enclosure kit, and the famous-value KNIGHT 3-Way 12-inch speaker. Just assemble the enclosure—*no finishing required*—all surfaces are finished in hand-rubbed Korina blonde, mahogany or walnut. The speaker is the new 3-way type: 12″ woofer cone for bass (full 1¾ pound woofer magnet), conical radiator for mid-frequencies, built-in compression-type tweeter (with wired level control and calibrated dial) for highest frequencies. Unexcelled enclosure efficiency and superb speaker performance combine to cover the whole spectrum of audible sound for true hi-fi response from 35 to 15,000 cps, ± 3 db. Kit includes 12″ 3-Way speaker, prefinished enclosure panels, grille cloth, hardware and instructions. *Specify Korina blonde, mahogany or walnut when ordering.* Shpg. wt., 44 lbs.

Model Y-937. 3-Way Speaker System Kit. Net only....... **$89.50**



knight-kit 10-Watt Hi-Fi Amplifier Kit

Y-753
$23.50
$2.35 down

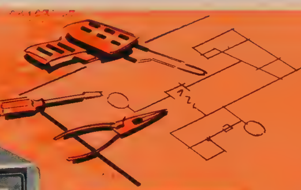
Low-cost, authentic hi-fi amplifier. Response, ± 1 db, 30-20,000 cps. Input for crystal phono or tuner; chrome-plated chassis is punched for preamp kit below, to permit use of magnetic phono. Only 0.5 volt drives amplifier to full output. Separate bass and treble controls. Only 1% harmonic distortion. Matches 8-ohm speaker. 7 x 13 x 6″. With all parts, tubes and instructions. Shpg. wt., 13 lbs.

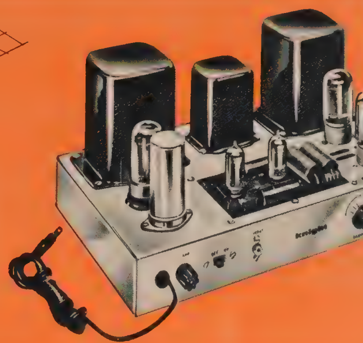
Model Y-753. Net only.. **$23.50**
Y-235. Preamp Kit..... **$ 3.10**
Y-757. Metal Cover.... **$ 3.95**

ALLIED RADIO *America's Pioneer in Electronic Kits*

knight-kits

THE VERY FINEST MUSICAL QUALITY—SO EASY TO BUILD
MONEY-SAVING HI-FI EVERYONE CAN AFFORD





So Easy To Build
Anyone can build KNIGHT-KIT Hi-Fi. No experience required to get top results!

knight-kit High Fidelity Preamplifier Kit

Model Y-754
$39.95
Only $3.99 down

- Exclusive Printed Circuit Switches and Boards
- Equalization ±½ db of Recommended Accuracy
- 8 Inputs Including Tape Head
- Self-Powered
- DC on All Tube Filaments
- Custom-Styled

Sensational Hi-Fi design at amazing low cost. Provides precise record equalization guaranteed within ½ db of recommended accuracy!—more accurate than all but the most expensive factory-built preamps. Includes exclusive new KNIGHT-KIT printed circuit switches for easy, error-free assembly; 2 printed circuit boards eliminate all other wiring, except for power supply and control leads—so easy to build. Has built-in power supply; includes premium 12AY7 and ECC82 tubes. Frequency response, ± 0.5 db, 10-50,000 cps. Has 8 inputs: Tape Head; G.E. Phono; Pickering Phono; Ceramic; Microphone; Auxiliary; Tape Preamp; Tuner. Level adjustment for tuner input. Includes separate Bass and Treble controls; separate Level and Loudness controls; Rumble Filter switch; DC on all tube filaments; cathode follower output; 2 extra AC outlets. You get every advanced hi-fi feature in this easy-to-build preamplifier at the lowest possible cost. Includes beautiful custom-styled French-gray case, with tapered chrome-finished legs, 4 x 13 x 8″. With all parts, tubes, step-by-step instructions; ready for easy assembly. Shpg. wt., 12½ lbs.

Model Y-754. Hi-Fi Preamp Kit. Net only **$39.95**

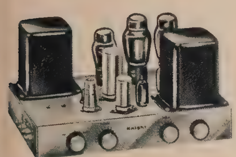
knight-kit 25-Watt Hi-Fi Basic Amplifier Kit

Model Y-755
$44.50
Only $4.45 down

- Hi-Fi Response, ± 0.5 db, 10 to 120,000 cps
- Only 0.15% Distortion at 30 Watts Output
- Printed Circuit Wiring Board
- Chrome-Plated Chassis
- Williamson-Type Circuit with Over 25 Watts Output

Here's superb Hi-Fi performance at less than half the cost of a comparable commercially-assembled unit. Williamson-type linear-deluxe circuit delivers over 25 watts of virtually undistorted reproduction. Ideal for use with the KNIGHT-KIT preamp at left. Includes printed circuit board for simplified, error-free assembly. Remarkable hi-fi response, ± 0.5 db, 10-120,000 cps at 20 watts. Harmonic distortion, 0.15% at 30 watts; IM, 0.4% at 20 watts. Hum level, 85 db below 25 watts output. Output impedances, 4, 8 and 16 ohms; output tubes, 2-5881. Includes balance control for precise matching of the output tubes; variable damping control for maximum performance with any speaker system—prevents low-frequency distortion from overdamping or underdamping. Very attractive black and chrome styling, 6¼ x 14 x 9″. An outstanding engineering achievement in a basic hi-fi amplifier, delivering performance equal to the finest commercially assembled units. Includes all parts and tubes; with step-by-step instructions, ready for easy assembly. Shpg wt., 25 lbs.

Model Y-755. 25-Watt Amplifier Kit. Net only **$44.50**
Y-759. Metal Cover for above; black finish. 5 lbs. Net **$4.25**



knight-kit 20-Watt Hi-Fi Amplifier Kit

Y-750
$35.75
$3.57 down

True hi-fi for less! Complete with full set of controls and built-in preamplifier. Response, ± 1 db, 20-20,000 cps; distortion 1% at 20 watts. Inputs for magnetic phono, microphone, crystal phono or recorder, and tuner. Compensation positions for 78 and LP records. Separate bass and treble controls. Output impedances, 4, 8, 16 and 500 ohms. Chrome-plated chassis. 7 x 13 x 8¾″. Ready for easy assembly. Shpg. wt., 20 lbs.

Model Y-750. Net only . . **$35.75**
Y-758. Metal Cover **$4.15**

knight-kit 2-Way Hi-Fi Speaker System Kit

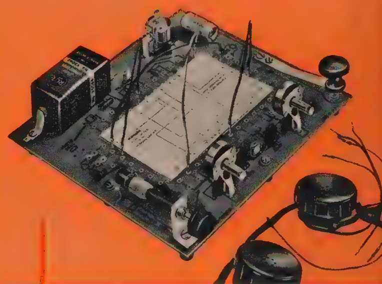
Model Y-789
$49.95
Only $4.99 down

- Easy to Assemble—Pre-Finished Enclosure
- High Fidelity Response, 45 to 14,000 cps
- 12″ Woofer and Horn-Type Tweeter
- A Wonderful Money-Saving Speaker Value

BIG SAVINGS—assemble your own quality KNIGHT-KIT 2-way speaker system—it's quick and easy! The cabinet is *pre-finished* in full-grained, high luster blonde or mahogany—you just assemble 7 pieces, mount the speaker components and enjoy rich, thrilling hi-fi sound—at incomparably low cost. Special Jensen-engineered baffle features "ducted port" construction to bring out the full beauty of bass notes, perfectly matching the Jensen woofer and compression tweeter; genuine L-pad control is rear-mounted to permit adjustment of tweeter for best tonal balance. Impedance, 16 ohms. The assembled unit delivers a frequency response of 45 to 14,000 cps. Enclosure measures 26 x 19 x 14″. Beautifully styled to blend in any room. Kit includes Jensen 12″ woofer, Jensen compression-type tweeter, pre-finished wood parts (with grille cloth installed), acoustic material, glue, hardware and step-by-step instructions. Absolutely no furniture finishing required. *Specify blonde or mahogany finish when ordering.* Shpg. wt., 33 lbs.

Model Y-789. 2-Way Speaker System Kit.
Net only **$49.95**

Fascinating ALLIED knight-kits FOR EXPERIMENTERS AND HOBBYISTS



knight-kit 2-Transistor Pocket Radio Receiver Kit

Model Y-262 $14.65

- Loud, Clear Local Reception
- Newest Printed Circuit Board
- Built-In Loop Antenna
- Complete Kit—Nothing Else To Buy

It's fun to build this pocket-size two-transistor radio—and you'll enjoy its crystal-clear local broadcast-band reception wherever you go! Fits in your pocket, or with its button-down flap, can be worn from your belt. Completely self-contained with built-in ferrite loopstick antenna—no external antenna needed. Extremely efficient reflex type 2-transistor circuit actually does the work of 3 transistors! Printed circuit board reduces building time to about one hour. Has air-dielectric variable capacitor for easy, accurate station tuning. Operates for months and months on long-life alkaline battery supplied. Sensitive miniature earpiece provides crystal-clear tone. Handsome tan carrying case, plastic-impregnated, is styled to resemble leather; only 4x3¾x1¾". Kit includes all parts, transistors, earpiece, battery and case. Shpg. wt., 1½ lbs.

Model Y-262. Net only **$14.65**

knight-kit "Trans-Midge" Transistor Receiver Kit

Model Y-767 $2.45

Tiny, cigarette-pack-size one-transistor radio kit—fascinating to build—so low-priced. This novel miniature receiver will provide endless listening pleasure the moment assembly is completed. Covers the local AM broadcast band with exceptional sensitivity and selectivity. Special features include: Efficient, slug-tuned coil for excellent station separation; external knob for easy station tuning; low-drain transistor operating for months from single penlight cell supplied; hinged-back, red plastic case. Kit includes all parts, transistor, battery, compact case and easy-to-follow instructions for quick assembly. (External antenna and headphones required.) Shpg. wt., 8 oz.

Model Y-767. Net only **$2.45**
J-149. 4000 Ohm Headphones. 1 lb. . . **$2.15**
C-100. Antenna Kit. 1½ lbs. **$1.03**

knight-kit 10-Circuit Transistor Lab Kit

Model Y-299 $15.75

Sensational experimenters' transistor kit—an electronic marvel! Perfect for experimenter, student or hobbyist. Assemble basic parts once, then complete project after project (10 in all), by simply plugging leads into proper jacks on printed circuit board—no wiring changes needed. You learn how transistors operate by "plugging in" to make any one of the following circuits; AM radio for strong headphone reception; 2-stage audio amplifier; wireless broadcaster; code practice oscillator; electronic timer; electronic switch; electronic flasher; photoelectronic relay; voice-operated relay; capacity-operated relay. Includes all parts, 2 transistors, battery, headphones, circuit leads, relay, photocell, special guide cards for each project, explanation of each circuit. 3 lbs.

Model Y-299. Net only **$15.75**

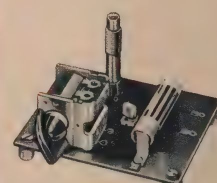
knight-kit 5-Transistor Superhet Personal Portable Radio Kit

Model Y-766 $29.95

- Styled to Equal the Finest
- Push-Pull Audio Drives 3½" Speaker
- Printed Circuit for Easy Building
- 200 Hour Battery Playing Life

Beautiful, easy-to-build transistorized personal portable with every ultra-modern design feature: 5 Texas Instrument Co. transistors; latest printed circuit chassis for easy, error-free assembly; bigger-than-average 3½" speaker; class B push-pull audio output; built-in high-gain ferrite loopstick antenna; plus phone jack output for private listening. Provides sensitive reception of the AM broadcast band with exceptional tone quality. Ultra-smart high-impact ivory plastic case has handsome gold trim with ebony accents; includes pull-out handle; only 7½x3⅜x1¾". With all parts, transistors, 9 volt transistor radio battery, carrying case and instructions anyone can easily follow. Shpg. wt., 2 lbs.

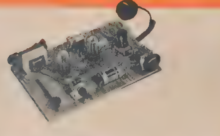
Model Y-766. Net only **$29.95**



1-Transistor Radio Kit

$3.95 Offers excellent AM local broadcast headphone reception. Printed circuit board for easy assembly. Operates from single penlight cell for months. Complete with all parts, transistor and penlight cell. (Antenna and headphones required.) Shpg. wt., 1 lb.

Model Y-765. Net only **$3.95**



"10-In-One" Electronic Lab Kit

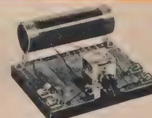
$12.65 Famous experimenters' kit. Builds any of 10 fascinating projects, including broadcast receiver, wireless phono oscillator, code practice oscillator, signal tracer, relays, etc. Shpg. wt., 5 lbs.

Model Y-265. Net only **$12.65**

"6-In-One" Electronic Lab Kit

$8.45 A favorite with beginners. After basic wiring is completed, you make circuit changes without soldering. Builds any of six favorite projects, including radio, wireless broadcaster, etc. Shpg. wt., 3 lbs.

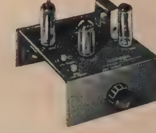
Model Y-770. Net only **$8.45**



Crystal Set Hobby Kit

$2.15 Entertaining, educational. Delivers clear headphone reception of local broadcast stations. With all parts, ready for easy assembly. (Antenna and headphones required.) Shpg. wt., 1 lb.

Model Y-261. Net only **$2.15**



Wireless Broadcaster Kit

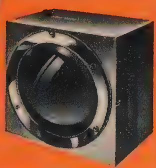
$9.50 Play music or make announcements through your radio set—no connection to set required! Loads of fun—easy to build. Works up to 50 feet from set. Shpg. wt., 3 lbs.

Model Y-705. Net only **$9.50**

FUN TO BUILD . . . INSTRUCTIVE . . . LATEST CIRCUITS FOR TOP PERFORMANCE

WIDEST CHOICE OF QUALITY HOBBYIST KITS





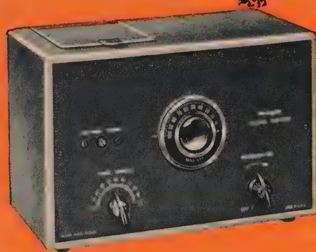
Interruption of light beam triggers relay, which in turn sounds chime or bell, turns on lights, etc.

knight-kit Photoelectronic Relay Kit

Model Y-702 $13.50 Advanced-design, ultra-sensitive photoelectronic relay—build it yourself and save! Dozens of uses: for automatic control of lights, door announcer, burglar alarm, counting devices, etc. Provides dependable operation up to 250 feet with white light, up to 125 feet with "unseen" light (red filter) from Light Source Kit listed below. Selectable operation, with "trip" for burglar alarm to provide continuous ringing of alarm; and "auto" if relay is to operate each time beam is broken (for chimes, counting devices, turning on lights at darkness). Has SPST relay operated from thyratron; 6.3 v. terminals provide power for accessories. For 105-120 v. 50-60 cy. AC use. 6 lbs.

Model Y-702. Relay Kit. Net only . . **$13.50**

Model Y-703. Light Source Kit. With bulb and red filter. Shpg. wt., 3½ lbs. Net . **$6.75**

knight-kit "Ocean Hopper" All-Wave Radio Kit

Model Y-740 $11.95 This top-performing regenerative receiver puts a world of listening pleasure at your finger-tips. Tuning range (using coils listed below) is virtually world-wide; covers 155 kc to 35 mc, including every type of radio transmission: AM broadcast, marine, aircraft, distress channels, direction-finding, Amateur, frequency standard, foreign broadcast, and police. With bandspread tuning. For use with headphones or 3-4 ohm PM speaker. Kit is supplied with standard broadcast band coil and all tubes and parts. (Less extra coils, headphones, speaker and cabinet.) Shpg. wt., 5 lbs.

Model Y-740. Net only **$11.95**

Y-746. Cabinet for above. 1½ lbs. Net **$2.90**

Extra coils available: Long Wave Coil (155-470 kc), Net 79c. Short Wave (1.65—4.1 mc; 2.9—7.3 mc; 7—17.5 mc and 15.5—35 mc), Each 65c.



knight-kit "Space-Spanner" Bandswitching World-Wide Radio Kit

Model Y-243 $15.95

- Broadcast or Short Wave Reception
- Sensitive Regenerative Circuit
- Convenient Bandspread Tuning
- Built-In Loudspeaker

Imagine the thrill of hearing overseas broadcasts on a precision receiver you've built yourself—and then, at the flip of a switch, being able to tune to your favorite local broadcast station! Bandswitch selects exciting short wave, including foreign broadcasts, amateur calls, aircraft, police and marine radio on the 6.5 to 17 mc range, as well as standard 540-1700 kc broadcasts. Features highly sensitive regenerative circuit. Includes built-in 4" PM speaker and beam-power tube for strong volume and clear tone. Headphone connectors are available for private listening; switch cuts out speaker. Controls: Bandspread, Main Tuning, Antenna Trimmer, Bandswitch, Regeneration, Volume. 7x10x6". Easy to build from step-by-step instruction manual. For 110-120 v., 50-60 cy. AC or DC. (Less cabinet.) Shpg. wt., 5 lbs.

Model Y-243. Net only **$15.95**

Y-247. Cabinet for above. Shpg. wt. 2 lbs. Net . **$2.90**

"Ranger II" Superhet Receiver Kit

$17.25 Popular Broadcast band receiver built and enjoyed by thousands. Features built-in antenna, automatic volume control, ball-bearing tuning condenser, PM dynamic speaker. Handsome plastic cabinet. Easy to assemble. AC or DC operation. Shpg. wt., 8 lbs.

Model Y-735. Net only **$17.25**

knight-kit 2-Way Intercom System Kit

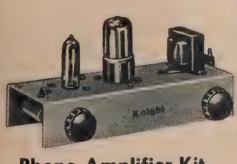
Model Y-295 $14.75

- Low Cost—Easy to Assemble
- High Gain—Clear Tone
- Handsome Metal Cabinets
- Includes 50-Foot Cable

Easy to build at lowest cost—ideal for home, office, shop or school. Consists of Master unit and Remote unit. Remote unit may be left "open" for answering calls from a distance, for "baby sitting", etc. Remote also may be set for "private" operation—cannot be "listened-in" on, but it can be called and can originate calls. Master unit includes high-gain 2-stage amplifier, combination volume control and on-off switch, plus pilot light. Each unit has 4" PM dynamic speaker. System responds to even a whisper. Handsome Antique white cabinets, each 4¾x6½x4⅜". With all parts, tubes and 50-ft. cable (up to 200-ft. may be added). For 110-120 v., AC or DC. 8 lbs.

Model Y-295. Master and one Remote. Net only . . **$14.75**

Y-296. Extra Remote Station Kit. 3 lbs. **$3.75**



Phono Amplifier Kit

$9.45 Build it yourself—and save! Ideal for use in a portable phonograph—just add record player and 3-4 ohm speaker. 1½ watts output. Inverse feedback circuit. Easy to assemble. Shpg. wt., 3 lbs.

Model Y-790. Net only **$9.45**

Electronic Photoflash Kit

$28.50 Ideal for color or black and white photography. 1/700th-of-a-second flash; 50 watt/second output. Synchronizes with any camera with X or O shutter. (Less battery.) Shpg. wt., 4 lbs.

Model Y-244. Net only **$28.50**

Code Practice Oscillator Kit

$3.95 Ideal for beginners learning the code. Transistorized circuit. Operates for months from single penlight cell supplied. Clear, crisp 500 cycle tone. Jacks for headphones; screw terminals for key. 1 lb.

Model Y-239. Net only **$3.95**

Phono Oscillator Kit

$5.85 "Broadcasts" recorded music through any standard radio set up to 50 feet away. No direct connection to set required. Easy to build—fun to use. Shpg. wt., 2 lbs.

Model Y-760. Net only **$5.85**

FINEST ELECTRONIC EQUIPMENT IN EASY-TO-BUILD MONEY-SAVING KIT FORM

Better By Far — ALLIED **knight-kit** QUALITY TEST INSTRUMENTS

knight-kit Low-Cost Tube Tester Kit

Model Y-143
$29^{75}

- With 16 Filament Voltages
- 600 Latest Tube Types Listed
- Easy-to-Read 4½" Meter
- Tests Series-String TV Tubes

Expertly designed for complete, up-to-date coverage of tube types. Tests *series-string TV tubes;* tests 4, 5, 6 and 7 pin large, regular and miniature types, octals, loctals, 9-pin miniatures and pilot lamps. Tests for open, short, leakage, heater continuity and performance (by amount of cathode emission). Big 4½" square meter has clear "GOOD-?-REPLACE" scale. With line-voltage indicator and line-adjust control. Choice of 16 filament voltages from 0.63 to 117 volts to check virtually all receiving tubes; blank socket for future type tubes. Universal-type selector switches permit selection of any combination of pin connections. Single-unit, pre-assembled 10-lever function switch simplifies and speeds assembly. Up-to-date illuminated roll chart lists over 600 tube types. Counter model case, 5 x 14 x 10". Easy to build. 14 lbs.

Model Y-143. Net only **$29.75**
Y-142. Portable Case model. 15 lbs. Net **$34.75**
Y-141. Picture Tube Adapter. 1 lb. Net ...... **$ 4.25**

knight-kit RF Signal Generator Kit

Model Y-145
$19^{75}

Build this wide-range, extremely stable RF signal generator—save two-thirds the cost of a comparable wired instrument! Large, semi-circular dial is clearly calibrated; range is covered in 5 separate bands for close accuracy in setting individual frequencies. Ideal for aligning RF and IF stages in radio and TV sets and for troubleshooting audio equipment. Delivers output on fundamentals from 160 kc all the way out to 112 mc; useful harmonics to 224 mc. Has built-in 400-cycle sine-wave audio oscillator for modulating RF; audio is also available externally. Features high-stability Colpitts circuit. Convenient jack for external modulation. Maximum audio output 10 volts; RF output over 0.1 volt on all ranges. Step and continuous-type attenuator controls. Supplied with precision-wound coils that require no adjustment. 7 x 10 x 5". Shpg. wt., 11 lbs.

Model Y-145. Net only **$19.75**

knight-kit 1000 Ohms/Volt VOM Kit

Model Y-128
$16^{95}

Exceptional accuracy and versatility at amazing low cost. Ideal for service shop, lab or Amateur use. Large 4½", 400 microamp meter with separate scales for AC and DC voltage and current, decibels and resistance. *Uses 1% precision resistors;* has 3-position function switch and 12-position range switch. *38 ranges* include: AC, DC and output volts, 0-1-5-10-50-500-5000 (1000 ohms/volt sensitivity); Resistance, 0-1000-100,000 ohms and 0-1 meg (center scale readings of 60, 150 and 1500 ohms); Current, AC or DC, 0-1-10-100 ma and 0-1 amp; Decibels, −20 to +69 in 6 ranges. Precision resistors are used as shunts and multipliers to assure exceptional accuracy of measurements. With all parts, battery, test leads and black bakelite case with convenient carrying handle, 6¾ x 5¼ x 3¾". A great value in an easy-to-build quality instrument. Shpg. wt., 2½ lbs.

Model Y-128. Net only **$16.95**

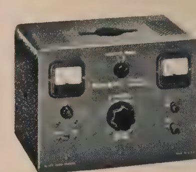
knight-kit Vacuum Tube Voltmeter Kit

Model Y-125
$24^{95}

- 200 μa Movement, 4½" Meter
- Includes AC, Peak-to-Peak
- Balanced-Bridge, Push-Pull Circuit
- 1% Film-Type Resistors

Top buy in an extremely stable, highly accurate VTVM. Easy to assemble—entire chassis is printed circuit board. Perfect for radio-TV service work, lab and Amateur use. Features low-leakage type switches; 1% film-type precision resistors; balanced-bridge, push-pull circuit (switch to any range without readjusting zero set); zero center scale and direct-reading db scale; polarity reversing switch. Ranges: Input Resistance, 11 megs; DC and AC rms, 0-1.5-5-15-50-150-500-1500; AC Peak-to-Peak, 0-4-14-40-140-1400-4000; Response, 30 cycles to 3 mc; Ohms, 0-1000-10K-100K and 0-1-10-100-1000 megs; db, −10 to +5. Includes all parts, tubes, battery, test leads and portable case, 7¾ x 5¼ x 4-5/16". Easy to assemble. Shpg. wt., 6 lbs.

Model Y-125. Net only **$24.95**
Y-126. Hi Voltage Probe; extends DC to 50,000 v........... **$ 4.75**
Y-127. Hi-Frequency Probe; extends AC to 250 mc.......... **$ 3.45**



6V-12V Battery Eliminator Kit

$32^{95}

High current rating; continuously variable filtered output; delivers 15 amps at 6 volts, 10 amps at 12 volts. May be used as battery charger. Two meters provide simultaneous current and voltage readings. Shpg. wt., 18 lbs.

Model Y-129. Net only....... **$32.95**

Transistor Checker Kit

$8^{50}

Checks gain ratio of all types of transistors; checks germanium and silicon diodes; checks for continuity and shorts. A valuable instrument at very low cost. Easy to assemble. Shpg. wt., 2½ lbs.

Model Y-149. Net only........ **$8.50**

Flyback Checker Kit

$19^{50}

Checks condition of all types of horizontal output transformers and deflection yokes, as well as TV linearity and width coils. 4½" meter; widest range in its field. Shpg. wt., 6 lbs.

Model Y-118. Net only....... **$19.50**

Sweep Generator Kit

$43^{75}

Extreme linearity on a par with costly lab instruments; fundamentals to 250 mc; output flat within 1 db; electronic blanking. Easy, money-saving assembly. Shpg. wt., 16 lbs.

Model Y-123. Net only....... **$43.75**

Capacitor Checker Kit

$12^{50}

Tests capacitors while in the circuit! Has widest range—20 mmf to 2000 mfd. Exclusive circuit for cancelling lead capacity. "Magic Eye" indicator. Save 60% over factory-wired units. 5 lbs.

Model Y-119. Net only....... **$12.50**

ORDER FROM **ALLIED RADIO** 100 N. WESTERN AVE. • CHICAGO 80, ILL

ADVANCED-DESIGN INSTRUMENTS FOR SERVICE, INDUSTRIAL AND RESEARCH USE IN EASIEST-TO-BUILD, MONEY-SAVING KIT FORM

knight-kit 20,000 Ohms/Volt VOM Kit

Model Y-140 $29^{50}

Outstanding quality and performance at money-saving low price. Features 1% precision multipliers; 4½" meter accurate within 2% of full scale deflection; 50 microamp sensitivity for 20,000 ohms/volt input resistance on DC; front panel "Zero adjust"; single switch to select function and range. 32 ranges: AC, DC and output volts, 0-2.5-10-50-250-1000-5000; Resistance, 0-2000-200,000 ohms and 0-20 meg.; DC ma, 0-0.1-10-100; DC amps, 0-1-10; Decibels, −30 to +63 in six ranges. Moisture-resistant film-type resistors for extreme accuracy. Carefully engineered circuit design achieves high sensitivity and extremely versatile application. Kit includes all parts, battery, test leads and black bakelite case with highly legible white markings; size 6¾ x 5¼ x 3¾". Easy to assemble. Shpg. wt., 5 lbs.

Model Y-140. Net only............ **$29.50**

knight-kit High-Gain Signal Tracer Kit

Model Y-135 $26^{50}

A remarkable value in an easy-to-build instrument which permits visual and aural signal tracing of RF, IF, video and audio circuits. Has *highest gain in its price class.* Traces signal from antenna to speaker. Reproduces signal at plate or grid connection of any stage. Identifies and isolates "dead" stages. Features: usable gain of *91,000;* "magic eye" with calibrated attenuators for signal presence indication and stage-by-stage gain measurements; built-in 4" PM speaker; combination 2-position probe, one for RF (6 mmf. input), the other for audio. Provides noise test; built-in watt-meter calibrated from 25 to *1000 watts;* provision for external scope or VTVM. Binding posts provide output transformer and speaker substitution test, plus external 280 volts B+. With all parts, tubes and probe. 7x10x5". 12 lbs.

Model Y-135. Net only............ **$26.50**

knight-kit 5" Wide-Band Oscilloscope Kit

Model Y-144 $69^{00}

Only $6.90 down

- 5 mc Width for Color TV
- Horizontal Sweep to 600 kc
- 25 mv/inch Sensitivity
- Z-Axis Input
- Printed Circuit Construction

Equals or betters the performance of commercially wired scopes costing far more. Two printed circuit boards and laced wiring harness assure wiring accuracy and cut assembly time. Ideal for lab use, color TV servicing and high frequency applications. Wide sweep range—*15 to 600,000 cps.* Vertical response, ± 3 db, 5 cps to 5 mc; only 1 db down at 3.58 mc color burst. High vertical sensitivity of .025 rms v/inch. Input capacity, 20 mmf. Outstanding features: cathode follower inputs; 2nd anode provides 1400 volts high-intensity trace; push-pull amplifiers; positive and negative locking; frequency-compensated attenuator; Z-axis input; one volt P-P calibrating voltage; astigmatism control; retrace blanking circuit; DC positioning control. Includes CRT. 14½ x 9½ x 16". 40 lbs.

Model Y-144. Net only.................... **$69.00**
Y-148. Demodulator Probe. Net............ **$ 3.45**
Y-147. Low Capacity Probe. 12 mmf. Net.... **$ 3.45**

Voltage Calibrator Kit

$12^{75}

Permits use of any scope as precision peak-to-peak AC voltmeter. Puts a true square-wave voltage on scope screen. Selects any voltage between .01 and 100 volts; feeds external signal direct to scope for instant comparison. Shpg. wt., 5 lbs.

Model Y-136. Net only....... **$12.75**

knight-kit 5" General-Purpose Scope Kit

Model Y-146 $42^{00}

Only $4.20 down

- Phantastron Linear Sweep
- 25 mv/inch Sensitivity
- Printed Circuit Board
- Retrace Blanking Circuit

Feature for feature the world's best oscilloscope kit value. A standout in its class with all these fine features: *Printed Circuit* wiring board and laced harness for quick, error-free assembly. *Phantastron Sweep Circuit* for high linearity of sweep from 15 to 150,000 cps. *25 Millivolts Per Inch Sensitivity*—3 times that of similarly priced scope kits. *Calibration Voltage*—1 volt peak-to-peak square wave, fully regulated. *Vertical Amplifier*—frequency response ± 3 db, 3 cps to 1.5 mc (± 6 db to 2.5 mc). Includes: Directly coupled positioning controls; retrace blanking circuit; frequency-compensated vertical input attenuator; positive and negative internal sync; high 2nd-anode voltage for high-intensity trace; input capacity, 45 mmf. Kit includes CRT. 9½ x 13¾ x 17¾". 26 lbs.

Model Y-146. Net only................................ **$42.00**

Resistance Substitution Box

$5^{95}

Easily determines resistor values required in a circuit. Makes available 36 standard 1-watt resistance values in 2 ranges between 15 ohms and 10 megohms, with 10% accuracy. Slide switch selects range; 18-position switch for value selection. Shpg. wt., 2 lbs.

Model Y-139. Net only.................... **$ 5.95**

Capacitance Substitution Box

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Makes it easy to find capacitor values needed in a circuit. Provides 18 standard values from .0001 mfd to .22 mfd. ± 20%. All values are 600 volt, except .15 and .22, which are 400 volt. 18-position selector switch. Shpg. wt., 2 lbs.

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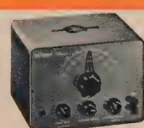

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$31^{50}

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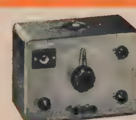

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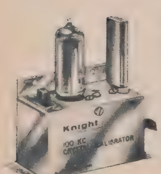

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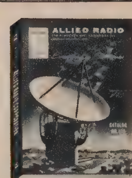

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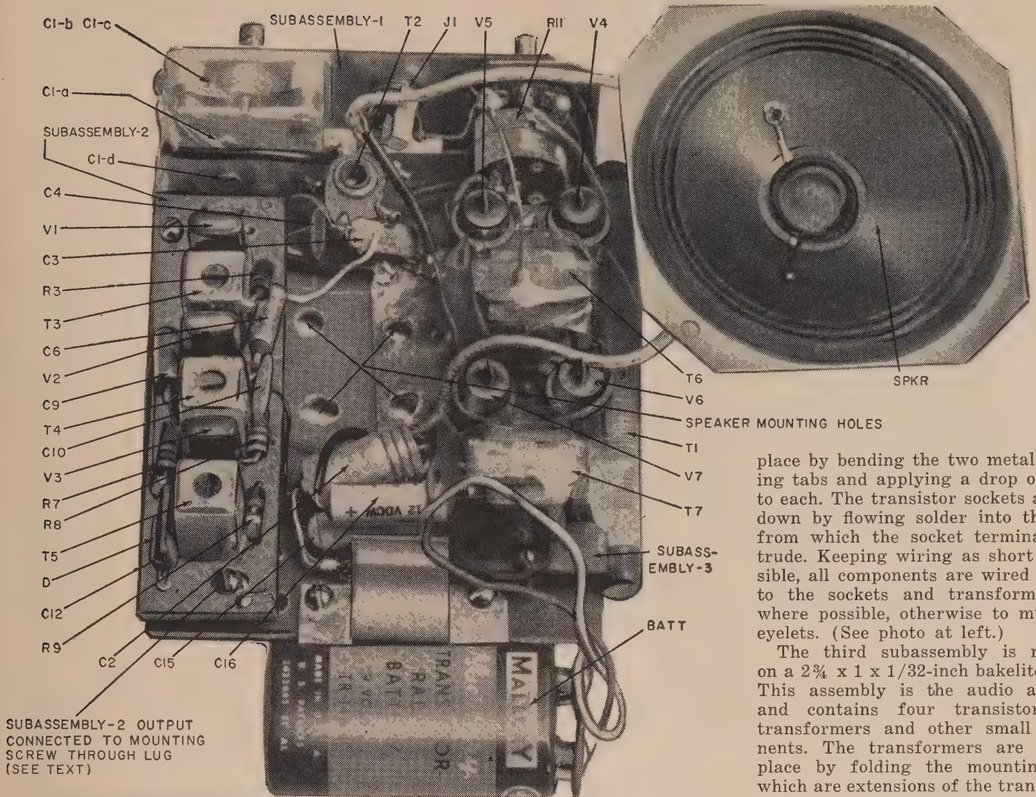
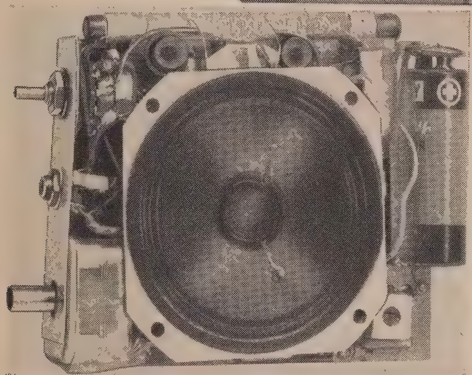


(Above) The receiver's chassis before the speaker is mounted.



(Left) Chassis view with speaker properly mounted.

(*Continued from page* 84)

second detector. The audio section contains four 2N107 transistors. One af ampl, one driver and two utilized in a transformer-coupled class-B push-pull power stage. Power is obtained from a 9-volt mercury battery.

Construction details

The receiver consists of a main chassis assembly, containing three subassemblies plus the antenna and oscillator coils, battery clip and loudspeaker. The first of the three subassemblies is a 1/32-inch-thick aluminum bracket which supports tuning capacitor, phone jack and volume control. Fig. 2-a

The second subassembly is mounted on a bakelite chassis 3¼ x ⅞ x 1/32 inch and contains the converter, if amplifier and second detector stages. To mount transistor sockets and if transformers locate each part in its permanent place on the blank bakelite chassis and with a sharp tool mark the spot where the terminal of each part touches the chassis. After removing the sockets and transformers, 3/32-inch holes are drilled. Each part is placed in its proper location and its terminals are pushed through the holes.

The if transformers are secured in place by bending the two metal mounting tabs and applying a drop of solder to each. The transistor sockets are held down by flowing solder into the holes from which the socket terminals protrude. Keeping wiring as short as possible, all components are wired directly to the sockets and transformer lugs where possible, otherwise to miniature eyelets. (See photo at left.)

The third subassembly is mounted on a 2¾ x 1 x 1/32-inch bakelite board. This assembly is the audio amplifier and contains four transistors, two transformers and other small components. The transformers are held in place by folding the mounting tabs, which are extensions of the transformer cover, under the chassis. Copper straps wrapped around the transformer add security and make good ground points (see Fig. 2-b). I found it convenient to slot the chassis so the tabs would fit into them and prevent the transformers from sliding around. As before, all small parts are wired directly between the major components or tied to eyelets.

On the main chassis a 3/16-inch mounting hole is drilled a bit to the right and rear of where the tuning capacitor will be located. The oscillator coil is inserted in this hole and cemented in place.

The first and second subassemblies are then set in place on the main chassis. Subassembly 1 (bracket supporting the tuning capacitor, phone jack and volume control) is secured as shown in the photo. Then assembly No. 2 is mounted on the left side of the main chassis just behind the tuning capacitor and held in place by two No. 4-40 screws. Two 3/16-inch spacers are used for support.

The output from the second detector on subassembly 2 is connected to a lug through which the rear mounting screw passes and is picked up by another lug on top of which the nut is tightened on the under side of the main chassis. A connecting wire is run from this lug (left rear corner) to an eyelet in the front right corner and then up to the volume control. Next make all

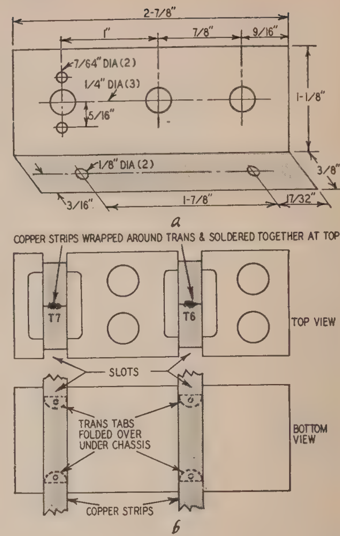


Fig. 2—a–Bracket to support tuning capacitor, phone jack and volume control; b–securing the audio transformers.

other connections between the main chassis and subassemblies 1 and 2.

Alignment procedure

At this point power is applied and all alignment adjustments made. A signal generator is connected between the antenna terminal of the tuning capacitor and ground. The generator settings are modulation, 400 cycles—30%; frequency, 455 kc; output, 15 μv. An ac vtvm is connected between the center terminal of the volume control and ground. With the control on full and the meter set to the .03-volt range, T5 is tuned for a maximum indication on the vtvm. T4 is then tuned to resonance. This is repeated with T3. Then repeat the whole procedure.

Upon completing the alignment of the if stages, the signal generator and radio dial are tuned to 1550 kc (connections between signal generator and radio remain unchanged). The trimmer of the oscillator section of the tuning capacitor is adjusted for maximum response. Next the generator and radio dial are set to 600 kc. The slug in the oscillator is now adjusted for maximum response. This whole procedure is repeated. The final adjustment consists of tuning the signal generator and radio dial back to 1550 kc and adjusting the trimmer of the tuning capacitor's rf section for maximum response. Correct operation of the receiver is indicated by a reading of .012 volt on the vtvm, when the radio and signal generator are tuned to 1000 kc.

When alignment is completed, power is removed and the loudspeaker prepared for mounting. I used a Lafayette SK-65. It is not equipped with mounting holes in the rear frame. Four holes, therefore, have to be drilled and tapped for 6-32 machine screws.

The holes must clear the magnet pole piece and side walls of the magnet housing. When drilling these holes, take care and don't get any metal filings between the voice coil and magnetic pole piece. I used cellophane tape to protect against this.

After the holes are drilled, the speaker with its voice coil terminals facing to the rear, is set in place in the center of the main chassis and as close to subassembly No. 2 as possible. With a scribe or some other sharp tool, the outline of the rear of the speaker in its permanent position on the main chassis is scratched. Next the speaker mounting holes are marked off. The speaker is removed and mounting holes are drilled in the main chassis. With the speaker fastened in place, subassembly 3 is mounted. This unit fits on the left side of the main chassis, directly behind the volume control, as shown in the photos. The mounting holes for this assembly are marked off next and drilled in all members. The amplifier strip is screwed in position, supported by two 3/16-inch spacers.

The battery clip is a standard holder for a Burgess Y-10 cell (Lafayette part MS-225) with its ends cut off. Mounting holes were drilled in each end of the battery-clip base and also in the rear and center of the main chassis. The battery clip is then mounted. When all remaining interconnections are completed, the receiver is checked for proper operation.

Mounting the speaker

The set is placed into its case and the position of the speaker hole marked off on the leather. A very sharp knife is used to cut a hole approximately ¼ inch smaller in diameter than the speaker cone. A sheet of 1/32-inch bakelite is obtained and a ring cut with an inner diameter of 2¼ inches and an outer diameter of 2½ inches. Next out of a piece of stiff speaker grillecloth, a circular piece is cut to fit exactly into the hole in the bakelite ring. The grillecloth is then cemented into place. After the cement sets the bakelite ring is glued over the speaker hole in the case and allowed to set. The battery is installed and the set placed into the case. Calibration is checked for the necessity of making an oscillator adjustment.

With the volume turned on full, signal generator connected and set up as before and an ac vtvm across the voice coil of the loudspeaker the readings for my receiver were:

Frequency (*kc*)	Input (*μv*)	Output (*volts*)	Gain (*db*)
600	15	0.25	84.5
1000	15	0.27	85
1600	15	0.25	84.5

The current drain from the battery is about 16 ma, which indicates a rather long battery life.

Local stations are easily received. Weaker stations can be heard by using an earphone plugged into J1. END

How far can you go in Electronics without a Degree?

Bernie Roth examines ribbon from printer during Field Engineering Laboratory period.

Without a formal degree, 25-year-old Bernie Roth is already established as a Computer Systems Field Engineer—handling a key responsibility with IBM. Bernie is part of a team maintaining an entire electronic digital computer system. In this assignment, he must stay abreast of all the most advanced electronic concepts—developing his professional know-how every day. "That's what's different about IBM," Bernie says. "The graduate engineer has an advantage anywhere—but here at IBM, the technician also can grow into managerial positions. IBM is one of the few organizations I know of that is willing to invest time and money in training the technical man—and then gauges his future ability strictly on performance."

IBM instituted its program for specialized technical training many years ago. The theory behind this built-in educational system asked the question: Why should the capable man be denied the opportunity simply because he lacks a formal degree? The wisdom and foresight of IBM's decision are reflected in the story of Bernie Roth—in the misgivings of his past—in the certainty of his future.

The Navy steers Bernie on the right course

When Bernie graduated from Flemington, N.J., High School in 1950, he received a general diploma—mathematics and science made up a small part of his curriculum. Enlisting in the Navy in 1951, Bernie proved his aptitude for technical work and was assigned to the electronics preparatory school in Jacksonville, Fla. Later, he attended the Class A Aviation Electronics School in Memphis, Tenn. . . . probably the most important phase of his naval training because it was in

Here, he scans the schematic of computer circuits.

Memphis that he became convinced that a technical career was "Right up my alley." But an event that occurred during a furlough in the spring of 1955 put a brand-new light on Bernie's future.

Reports for training

Bernie smiled when he mentioned that his mother had a tendency to clip want ads. "It was just pot-luck that one of the ads she spotted was for IBM Kingston and Project SAGE." Soon afterwards, Bernie hopped a bus to Newark for an interview with the IBM representative. He took the required number of tests—talked over his hopes and ambitions, and "That's about all there was to it." In July, Bernie notified IBM that he was definitely available, and supplied the necessary references. Meanwhile, he made a study of IBM's history, its policies, its growth, and its future—all of which impressed him favorably. One day in September, Bernie received instructions to report to Kingston to begin training as a Computer Units Field Engineer.

The material he studied at Kingston

"The Kingston program is a real experience, and quite an eye-opener in electronic techniques. First of all, I studied basic circuitry. Then, I actually learned a new way to think—the ability to comprehend the whole from the assorted parts. The student must know how to form logic blocks, and in time, he should be able to design his own circuits. All of this proved especially helpful once I got into the field. Later on, I studied the various input-output devices which are used as auxiliary units to the central computer. Finally, I analyzed the methods that supply the power for this electronic giant. Millions of

Bernie checks a unit in one of the operating consoles.

watts are needed—a phenomenal amount. In general, I'd say that you couldn't find a better training ground for understanding the uses of electronic as well as electromechanical equipment."

Promoted to Computer Systems Field Engineer

Early this year, following additional training and on-the-job experience, Bernie became a Computer Systems Field Engineer and was assigned to Santa Monica, Calif. "I'm responsible for performance and evaluation of the system as a whole. I direct and conduct reliability testing and maintenance of computer equipment. The many Project SAGE outposts—picket ships, reconnaissance planes, Texas towers—flash their signals to input devices which, in turn, correlate and compile data for the main computer. After processing, data is available either through displayscopes, fast photographic devices, or printed data. The SAGE computer, incidentally, is the world's largest computer. It's built and tested at Kingston, then disassembled and shipped to directional control sites. My work is always different, never routine, and that's very important to me."

How does the future look to Bernie?

A happy and prosperous future is in the offing for Bernie Roth. Now a Computer Systems Field Engineer, he's confident that in a short time he will qualify as a Group Supervisor, and the next step up the ladder would be Group Manager. "The real satisfaction in working with IBM," Bernie says, "is the opportunity to learn and understand more and more about electronic techniques. IBM is quick to recognize and reward improved ability through greater knowledge."

An outdoor man, Bernie takes full advantage of available hunting facilities.

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TRANSISTOR & HYBRID AUTO RADIOS

By JACK DARR

Part I—New tricks in an old trade, or "Look, Maw, no vibrator!"

THE inverted technician who sticks his head under the dash of a new car is quite apt to find out that something new has been added in the auto-radio department. He is also quite apt to find that something old has been taken away! Especially, if he uses the oldest test in the book for auto radios: turning it on and listening for the vibrator!

Beginning with a few models last year and continuing in still greater numbers this year, the leading set makers are incorporating transistors in their auto radios. This is actually the first basic change in auto-radio design since the elimination of the B-battery box! Many of these sets use low-voltage tubes and transistors and thus have no high-voltage supply at all, ending the need for the familiar vibrator.

The new radios may be divided into three classes roughly speaking: the hybrid sets, using power transistors in the output, with conventional tubes in the rest of the stages; the hybrid sets using transistors for output, with the special low-voltage series of tubes, developed last year, which require only 12 volts plate or screen and, finally, the all-transistor sets. There are subclasses and variations of these, of course, which will be discussed as we go along.

Numerically, about the most popular of these seems to be the hybrid sets with power transistors in the output stage. Such transistors as Delco's 2N173, which may be superseded by the newer 2N278, Motorola's 2NJ4 (2N176, 2N178) and the Philco AR-6 and AR-5 are found here. These are all very similar in shape, differing mainly in type number and mounting methods. Driving *power* for these is furnished by an extra stage of audio amplification. This may be a tube or a lower-power transistor.

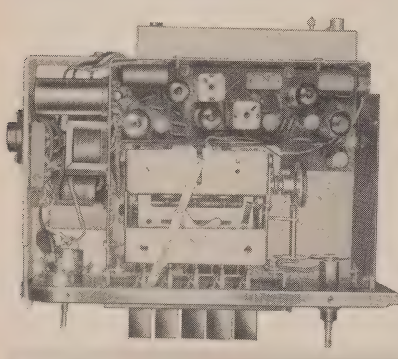
Coupling transistors

Transformer coupling between stages, not seen in commercial design for some time, is making a comeback. Proper impedance matching is very important in transistor circuitry: the transistor is a fairly low-impedance device compared to the very high impedances found in tube circuitry and the matching transformer plays a very important role. A tapped autotransformer is found in several circuits, stepping the higher output impedance of the transistor driver down to match the low input impedance of the following transistor stage.

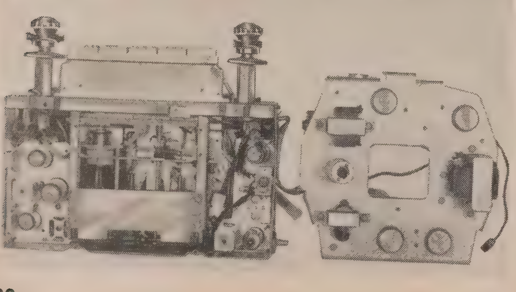
Some single-ended circuits even use an autotransformer as an output transformer, tapping the 4-ohm speaker down on the single winding to a point 4 ohms from the ground end. After all, impedances are matched mainly to achieve maximum *power* transfer and the transistor is primarily a power-handling device, both on the input and output, as contrasted to the voltage-input–power-output vacuum tube. These considerations are taken care of in the design of the radio: all that the service technician is expected to do is restore the circuit to its original operating condition!

Typical of the transistorized hybrids made by Philco are the P-5701 and C-5707 radios. These sets differ mainly in their cases, using the same circuit internally. The AR-5 power transistor is used in the power output stage (see Fig. 1) and is mounted on a heat sink on one end of the chassis. The new series tubes that require only 12 volts on plate and screen are used elsewhere, eliminating the need for the vibrator and vibrator transformer.

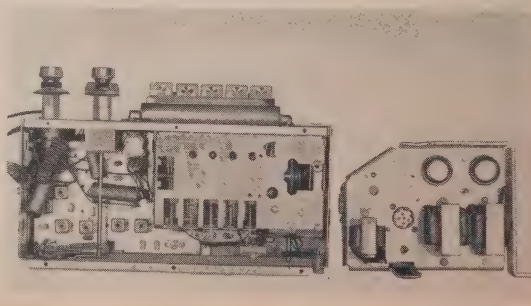
Delco is making quite a few transistorized sets, both hybrid and all-transistor types. Typical of the hybrids is the Pontiac model, part of which is shown in Fig. 2. This is almost identical, circuit-wise, with the Chevrolet 987575, using the same tubes and transistor. A 12AF6 is used as rf amplifier; a 12AD6, oscillator–mixer; another 12AF6 in the if stage; a 12F8 detector, while the drive for the 2N173 output is furnished by a 12K5. Notice the autotransformer used as output transformer.



(Left) Philco P-5701 auto radio. Power transistor on heat sink at left.



(Below left) Chassis view of Corvette radio. Audio transistors and power supply transistors on separate chassis.



(Below right) Cadillac all-transistor radio. Output transistors on chassis at right.

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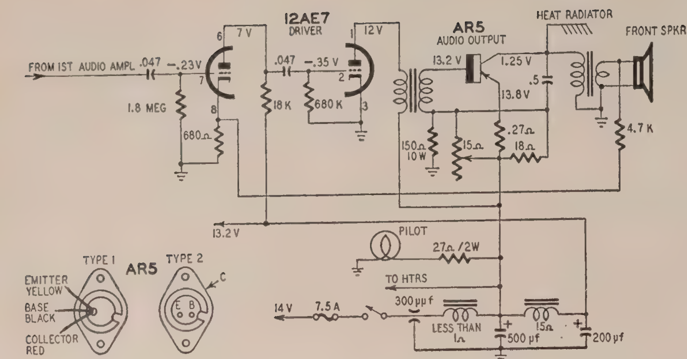

Fig. 1—Circuit of the Philco P-5701 and C-5707.

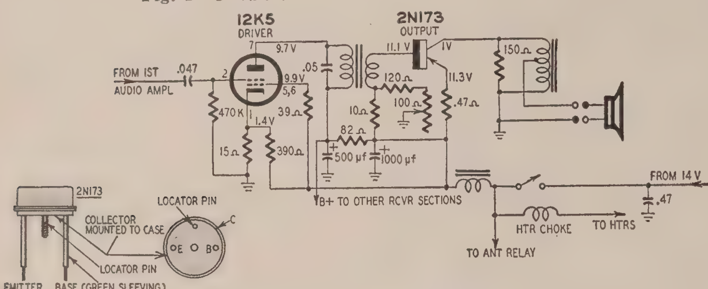

Fig. 2—Delco's Pontiac model 988671. The 12K5 grids are correct as shown.

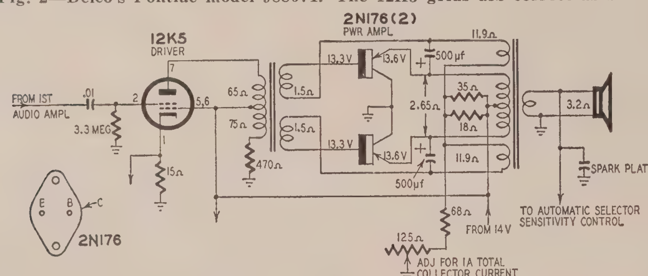

Fig. 3—Motorola 6TAS8 has push-pull transistor output stage.

Delco's first transistorized radio was the hybrid model 3725156 found in the Corvette sports car. This set has six conventional tubes, 12BA6, 12BE6, etc., in a standard circuit, with two 2N173 transistors in a push-pull power output stage.

A new application for power transistors is found in the power supply: two type 2N174's are used to replace the vibrator! (The schematic will appear in a later installment of this series.) They are hooked up in a push-pull oscillator circuit, using a special transformer. The high-voltage secondary of this is connected to a 12X4 and rectified in the normal manner. Output is about 200 volts, a customary value for auto radios.

Delco Cadillac 7268085

Delco's first completely transistorized radio is the model 7268085 used in the Cadillac Brougham. This set has a total of 13 transistors and 4 crystal diodes. A 2N150 is the rf amplifier, while 2N149's are used in the oscillator, modulator (mixer) and the first and second if amplifier stages. The third if amplifier is a type R-63, the detector a type R-62, with a type R-64 used as the agc amplifier. In the output stage, a 2N109 drives a push-pull pair of 2N278's. The signal-seeking tuner in this set uses a 2N149 as the trigger amplifier, with a 2N109 as the relay control unit. Together, these two transistors replace the familiar 12AU7 used for the same purpose in previous sets.

Two speakers are used, one in front and the other in the rear seat. A fader type control selects the volume level desired for each. Using all transistors, the set does not need a high-voltage power supply; all operating voltages are supplied by the car's 12-volt battery.

The most unusual feature of this and similar sets, to the technician accustomed to the large currents drawn by older sets, will be the current drain: *2 amperes!* This small drain is made possible by eliminating the vibrator, power transformer, rectifier tube and filaments which, although necessary for the functioning of the (tube) set, make no contribution to amplifying the signal. The current used by the all-transistor set is practically all applied to direct signal amplification!

Motorola's entry in the hybrid field consists of several models, beginning with a five-tube one-transistor chassis. These sets use the low-voltage tubes, with a 2N176, 2NJ4 or 2N178 transistor in the power output stage. Circuitwise, they are quite similar, using a 12BL6 rf amplifier, 12AD6 converter, 12BL6 if amplifier, 12AE6 second detector–avc-amplifier and a 12K5 as a driver for the transistor. They are built to fit the 1957 Dodge, DeSoto, Plymouth, Ford, Chevrolet and other cars.

Next is a chassis using the same tube lineup except for 12AC6's in the rf and if stages. This may be used, with the proper installation kit, in 1955 and 1956 Chevrolet, Buick, Oldsmobile, Pontiac and Studebaker cars, including the Hawks. This model, the 6TAS8, has a search tuner. Battery drain, at a 12-volt input, is only 2.7 amps and power output is 2.5 watts at normal volume with a 4-watt maximum.

A six-tube one-transistor chassis with search tuning, the MoPar 918-919, is used in the Dodge and DeSoto. Tube lineup is the same as in the sets previously mentioned, with a 2N176 power transistor. A novel feature of this chassis is the mounting of the transistor on a separate chassis, with the output transformer, heat radiator, etc. This is installed on the firewall for better cooling of the transistor.

The FEG-118806-G, an eight-tube chassis, with one transistor, using search tuning, is designed for custom installation in the 1957 Fords.

Two 2N176's are used in the output. They are mounted on the back of the case, with heavy aluminum heat-radiating fins. A sensitivity control is provided on the tuner for town and country areas. Manual pushbutton tuning is also incorporated in this design. This is the familiar cam and lever type.

Possibly the most elaborate set in the line is the Ford FEJ-18806-C (Motorola 79MS) designed for the Ford Thunderbird. Its output circuit is shown in Fig. 3. Nine tubes and two transistors power this one, which incorporates the Volumatic agc circuit, described in the next installment, and the Eliminoise circuit to reduce noise pickup from power lines. Sensitivity control for the search tuner is also used.

Next month we discuss some of the interesting and different features of this new crop of auto radios. Transistor power supplies to replace the vibrator and a combined avc–agc circuit will be described. Further articles will cover servicing problems in the new radios. TO BE CONTINUED

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By JAMES A. McROBERTS

The transistor superhet's local oscillator and how to handle it

SERVICING TRANSISTOR RADIOS

WHEN a transistor supplants the tube in a superhet's local oscillator, some new service problems arise. One is unfamiliarity with the circuitry of separate oscillators and oscillator sections of converters using a transistor. Another is the difficulty of determining when the oscillator is oscillating. And then there are subminiature parts and printed circuits to make servicing more difficult. Servicing procedures must follow an analysis in preference to cut and try.

Basic action

The basic ac circuit of transistor local oscillators and oscillator sections resembles their tube counterparts as Fig. 1 illustrates. We have a black box containing an amplifier of gain A in both instances. A portion of the amplifier's output is fed back into its input. The feedback must exceed 1/A as in tube circuits. Due to low resistances between the electrodes of the transistor, the feedback in excess of 1/A must be considerably greater than in tube types, where these interelectrode resistances and capitances (B–E, B–C and C–E) are relatively nonexistent. Total feedback must be 1/A plus all losses.

If feedback is to the transistor's base, phase is reversed, as indicated by polarity signs (Fig. 1-a). Feedback to the emitter does not require phase reversal (Fig. 1-b).

Gain A of the transistor is governed by its quality and the relative currents its electrodes are permitted to draw. The currents are governed by the supply voltages and circuit resistances in series with emitter, base and collector.

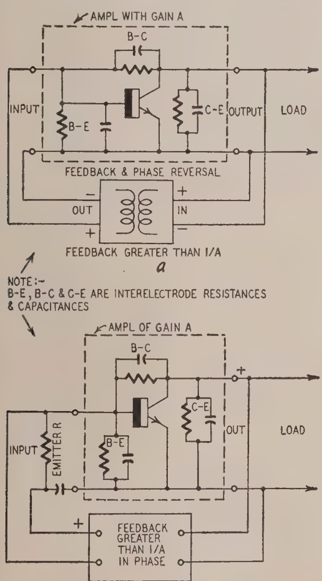


Fig. 1—Black-box analogy of transistor oscillator ac action: a—base injection type; b—emitter

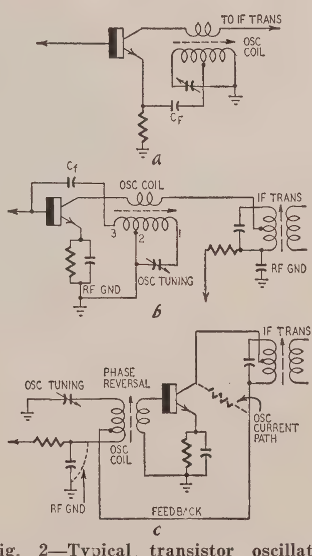


Fig. 2—Typical transistor oscillator circuits.

Assuming the transistor has sufficient gain (satisfactory transistor with proper electrode current supply), ac action is determined by the feedback circuit. The type of transistor (n-p-n or p-n-p) may be neglected in considering ac action. The circuits are similar for both types.

Fig. 2-a shows a typical converter type of local oscillator circuit abbreviated to illustrate only the rf (ac) action. The output of the transistor amplifier (from the collector) feeds through the oscillator coil's untuned winding. Output energy is transferred into the tuned winding by mutual inductance. A variable capacitor tunes this winding with the aid of an adjustable slug. Energy is fed back to the emitter via the feedback capacitor C_f. Since the emitter resistance is not bypassed to ground, the circuit acts like a grounded-grid amplifier in a vacuum-tube circuit. (The emitter is part of the base or input circuit.) Feedback is in phase here. The tap on the tuned winding fixes the amount of feedback.

Fig. 2-b illustrates base feedback. Output energy is transferred to the tuned winding as before. Out-of-phase energy is supplied the base through C_f. (Terminal 3 is in phase opposition to terminal 1.) An rf ground is required across the emitter resistance and from the end of the if transformer. The winding's capacitance furnishes a path for the oscillator current through the if transformer.

Fig. 2-c is similar to Fig. 2-b, with phase reversal being accomplished by proper connection to the pickup coil in series with the transistor's base. Since the collector is furnished with dc power through the oscillator coil, an rf ground is required at its cold end. The emitter likewise must be bypassed.

Typical commercial versions of the circuits of Fig. 2 are shown by Figs. 3,

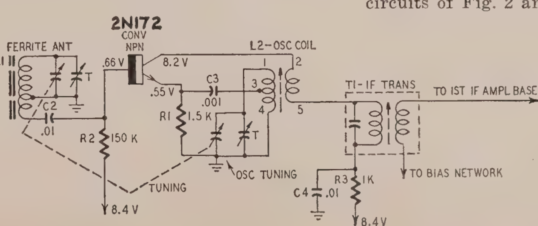
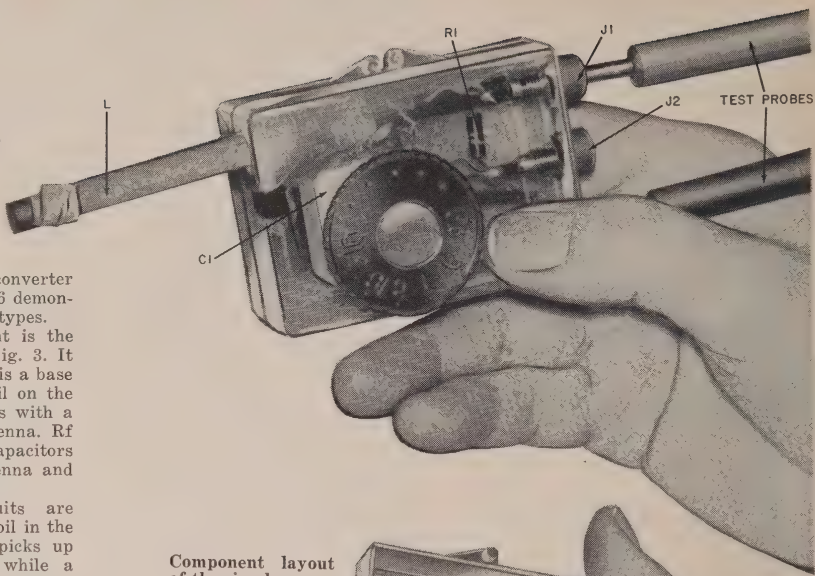


Fig. 3 — Partial diagram of Westinghouse H-587-P7 converter using emitter feedback.

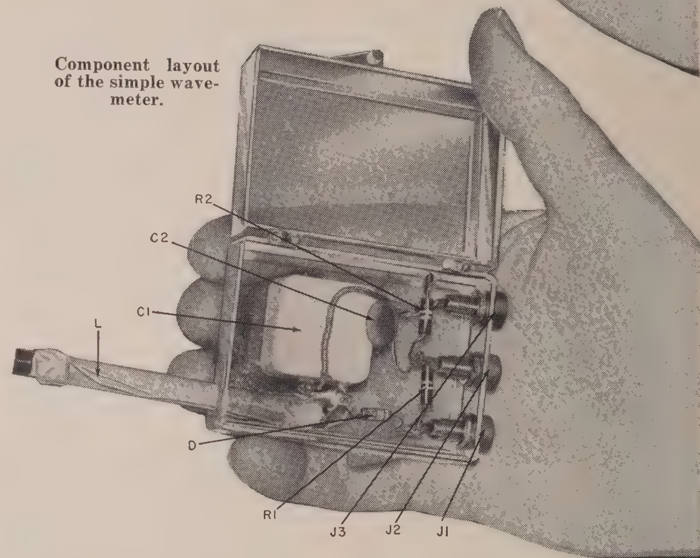


The wavemeter, ready to use.

4, 5 and 6. Figs. 3 and 4 are converter applications while Figs. 5 and 6 demonstrate separate local oscillator types.

Very popular at the present is the emitter injection variety of Fig. 3. It follows Fig. 2-a closely. Fig. 4 is a base feedback with the coupling coil on the oscillator transformer in series with a pickup coil on the ferrite antenna. Rf (ac) grounds are supplied by capacitors C2, C3 and C4. Both the antenna and the oscillator coil are hot.

The local oscillator circuits are straightforward. A coupling coil in the emitter return of the mixer picks up oscillator energy in Fig. 5 while a coupling coil on the ferrite antenna is furnished oscillator energy via C4 in Fig. 6. When replacing these coils, polarity may have to be reversed to maintain proper sense of feedback.



Component layout of the simple wavemeter.

Troubleshooting

The first phase of troubleshooting should be directed toward learning whether the oscillator is oscillating. Since little change in voltage occurs across any resistor in a transistor oscillator, by contrast with the developed voltage across a grid leak in tube types, some substitute must be found for the voltmeter to check for oscillator action. One method is to use a working broadcast receiver. Its antenna is brought near the transistor radio's oscillator coil. If the broadcast set is tuned to some station between 950 and 1,650 kc and the tuning dial of the transistor radio is rotated, a birdie will be heard if the transistor local oscillator is functioning. Absence of a birdie means no oscillation at that frequency.

A communications type or shortwave receiver can extend the range to the 2,100 kc required to cover the entire transistor local oscillator range—most such sets employ 455 kc as the if, hence $1,650 + 455 = 2,105$ kc. As most communications sets have an S meter or some form of avc indication, there is no need for having a station present as in the ordinary broadcast set. The meter will indicate a CW rf signal which can be identified by tuning the transistor radio dial which tunes the transistor local oscillator. The relative strength is indicated by the S meter or its equivalent.

If the shop has a grid-dip meter with wavemeter functions, it too may be used. Its coil is brought near the transistor local oscillator coil and the grid-dip meter tuning is turned slowly. The dip will indicate oscillation, and the amount of the dip will be roughly proportional to its strength with equal distance separating oscillator and dip-meter coil.

Another alternative is a simple wavemeter, which can be constructed quickly at low cost. The schematic is presented at Fig. 7 while the photos show its construction. The ferrite antenna is modified by removing about 10 turns from the white end. It is fastened in place through a hole in the plastic case with several dabs of glue. A crystal diode rectifies any oscillatory current picked up by the antenna and tuned by the midget variable capacitor across it. The diode's dc load has two outputs to accommodate a vom or vtvm. The vom is hooked between J1 and J3 and is used on its microampere range. The other output is between tip jacks J2 and J3. It is the voltage output for the vtvm.

In operation the antenna is pointed at the suspect circuit's oscillator coil from a distance of about 3 inches. The dial is turned and any oscillation is revealed by a deflection of the meter. The relative strength is proportional to the meter indication, provided distance and orientation of the antenna with respect to the oscillator coil remains approximately constant.

At resonance, the pickup coil can be moved closer to the oscillator coil until the oscillator conks out. About 150 μa can be delivered to a vom or about 2 volts to a vtvm. Probe the highest frequency in a transistor oscillator since it will tend to fail there in contrast to the lowest frequency in a tube oscillator or oscillator section. Unless 50 μa on a vom (move to a higher scale if necessary) or 1 volt on a vtvm can be ob-

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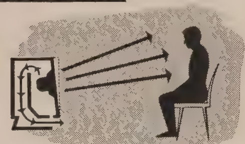

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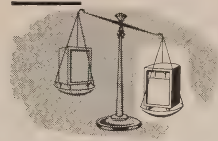

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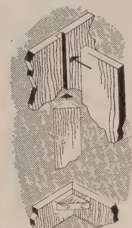

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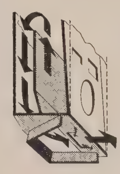

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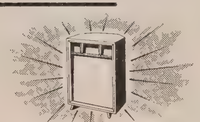

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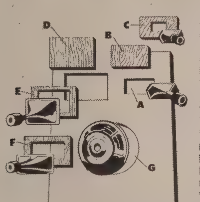
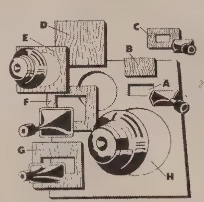


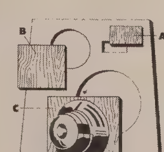
A—Hole cut out for HF-206.
B—Blank plug supplied when tweeter isn't used.
C—Adapter supplied cut out for UXT-5.
D—Blank plug supplied.
E—Adapter supplied cut out for 4409.
F—Adapter supplied cut out for H-600 horn.
G—Takes 312, UXC-123, Diffusicone-12, UXC-122, Diffaxials, 6200, 6201 wide-range speakers and C-12W woofer.

MODEL KEN-12
takes any 12" wide-range or woofer cone speaker and any tweeter or mid-range speakers.



A—Hole cut out for HF-206.
B—Blank plug supplied when tweeter isn't used.
C—Adapter supplied cut out for UXT-5.
D—Blank plug supplied.
E—Adapter supplied cut out for C-8W or Diffusicone-8.
F—Adapter supplied cut out for 4409.
G—Adapter supplied cut out for H-600 horn.
H—Takes 315-C, 6303, Diffusicone-15 Diffaxials, and C-15W, C-63W woofers.

MODEL KEN-15
takes any 15" wide-range or woofer cone speaker and any tweeter or mid-range speakers.



A and B—Blank plugs supplied.
C—Takes 312, UXC-123, Diffusicone-12, UXC-122 Diffaxials, 6200, 6201 wide-range speakers and C-12W woofer.

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tained, prior to the conking out, it is advisable to replace the oscillator coil, the feedback capacitor or both to obtain a satisfactory voltage. At least this amount should be secured over the entire band. If the oscillator fails at the extreme high frequency, 2,000 kc or so, replace the transistor rather than the coil or feedback capacitor.

The dial on the instrument shown in the photos is calibrated in the rf frequency of the set being probed. The actual oscillator frequency is higher by the if, which is usually 455 kc. As an example, 1,600 on the dial actually means 2,055 kc.

Gain troubles

If amplification A (Fig. 1 discussion) falls off as at the high-frequency end, the oscillator may stop or it may not have sufficient output for good mixing. Both troubles will be shown by the wavemeter just described.

Low gain means a bad transistor, improper voltages or defective circuitry.

First, check the voltages present at the transistor with a relatively high-resistance voltmeter. A vtvm or a 20,000-ohms-per-volt vom is satisfactory. Pay particular attention to base and emitter voltages. The emitter is almost at base voltage. Base must be a trifle more negative for a p-n-p transistor or a trifle more positive for a n-p-n type, converter operation presumed. Separate local oscillators exhibit somewhat greater base–emitter differences. Even greater tolerance is permitted at the collector in both types.

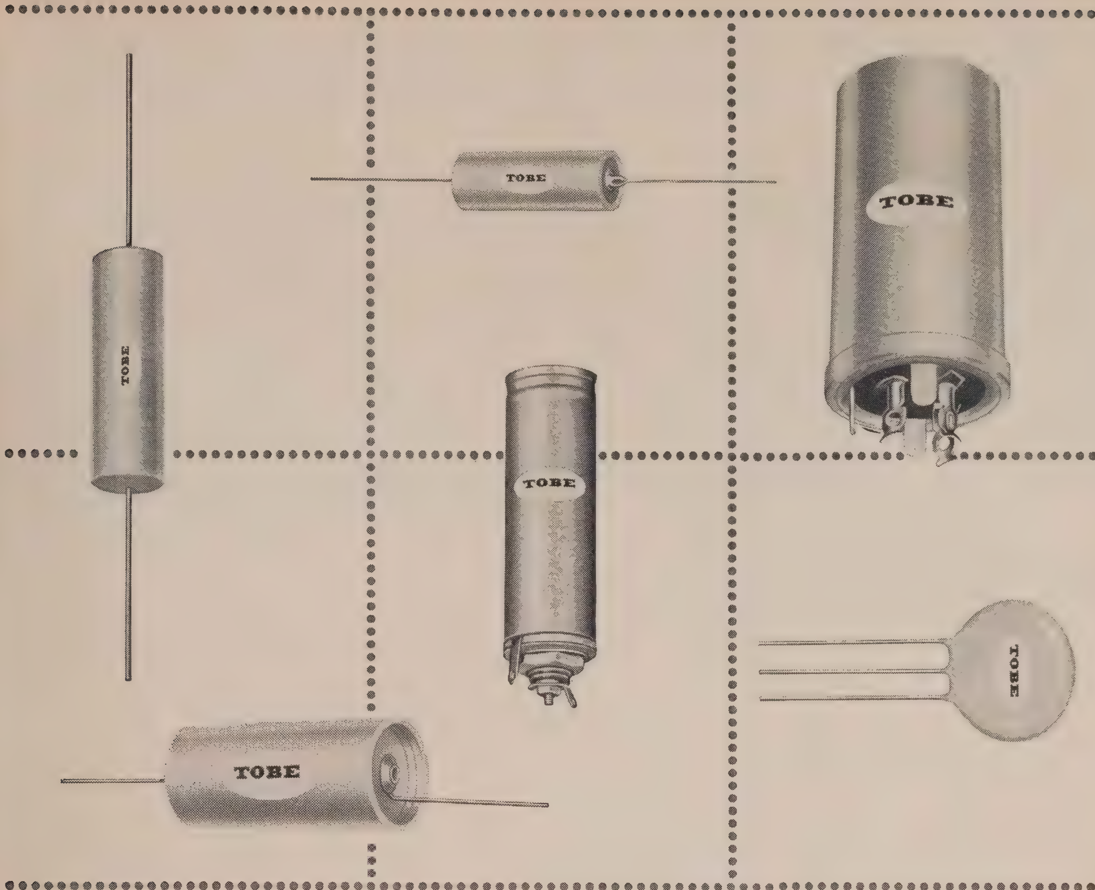
Slight creepage due to aging may upset the rather critical base–emitter differential. And base or emitter voltages, or both, may require doctoring. Easiest to operate on is the emitter. Shunt the emitter resistance with a larger-ohmage resistor or preferably a potentiometer. If the oscillator starts, as evidenced by an oscillation test, the trouble has been localized. In making a permanent replacement, use less emitter resistance than necessary to start the oscillator. The oscillating transistor must have greater gain than just enough to maintain oscillation.

This is also true for the base supply network. Usually the base supply is provided by a series resistor and another that shunts the base to ground—a bleeder resistor such as Fig. 5 shows. Here R1 (3,900 ohms) is the series resistor while R2 (2,700 ohms) is the shunt bleeder. Replacement with 5% tolerance units may be required. Such a resistance network may be shunted as a service test by a higher resistance. A pot of about 25,000 ohms makes an excellent test gadget here. Shunting the shunt resistor will lower the base voltage and a shunt across the series resistor will increase the base voltage.

Any shunt test (Fig. 5) across the emitter resistance should be across the resistance — not always from emitter to ground.

Capacitor and coil checks

Capacitor rf bypasses are used fre-


TOBE


TOBE
TOBE

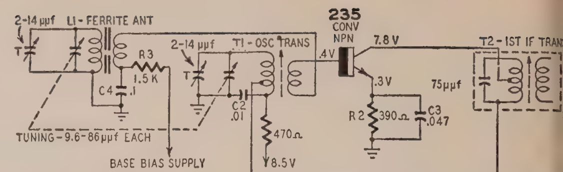


Fig. 4 — Converter of RCA 7-BT-10K features base feedback.

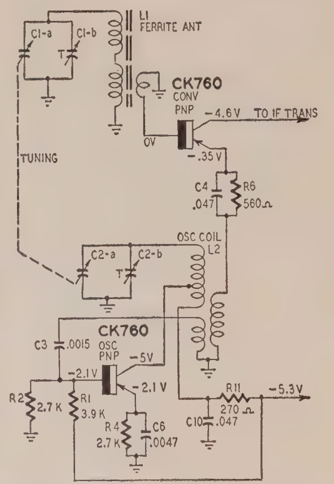


Fig. 5—Emitter feedback from separate local oscillator in Raytheon model 8TP2.

quently in transistor local oscillators. These can be checked by shunting with a capacitor of about the same value. The wavemeter may be left near the oscillator and tuned when each capacitor is shunted to see if the oscillator starts. Also check the coupling and feedback capacitors (such as C3 of Fig. 5, C4 of Fig. 6, C3 of Fig. 3). If any of these capacitors should lose an appreciable amount of their capacitance, the local oscillator will cut out. The same is true of excessive leakage but this will be shown by changed electrode voltages in most instances.

Most coils in the oscillator circuit may be checked by voltage measurements. If resistance checking is required, remove the transistors from their sockets to

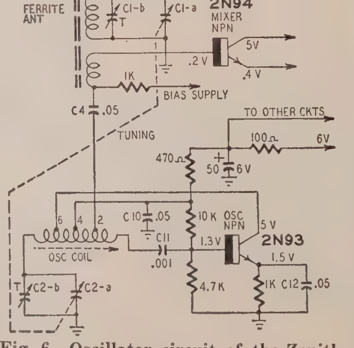


Fig. 6—Oscillator circuit of the Zenith 500.

prevent damage to them and erroneou readings (unless otherwise specified o the manufacturer's schematic). B careful to observe polarity with respec to any electrolytic capacitors in th circuit — these bantam types can b ruined by reversed ohmmeter polarity (The minus sign on a vom or vtvm ma not indicate minus in the ohmmeter cir cuit. Find out which is which befor using the instrument on transistor cir cuits.)

Shorting ferrite antenna couplin coils (see Fig. 4) or the if transforme section (jumper from collector to ta on oscillator coil, Fig. 4) will show u some faults without resistance checking

Phase reversal in the circuit canno occur unless parts have been replaced or perhaps tested by someone previous ly. It is necessary that the proper phas be maintained on replacement, as men tioned in conjunction with Figs. 3, 4, and 6. If the oscillator does not star after such replacement, check for re versed terminals.

The transistor

Since the proper transistor may no be readily available for substitution checking, the elimination of other pos sible causes of oscillator failure i undertaken first. Testing a transistor i a transistor tester may or may not show up trouble, since cutoff frequency is no measured. Nor is the amplificatio measured with sufficient accuracy t predict performance in a particula type of local oscillator. Hence, substi tution is the only practical way to tes the transistor. Even then, check bas and emitter voltage on the new transis tor in place in the set, and remedy dis crepancies from manufacturer's dat by doctoring resistors. EN

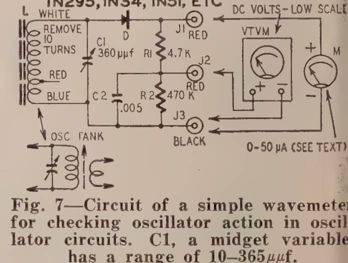


Fig. 7—Circuit of a simple wavemeter for checking oscillator action in oscil lator circuits. C1, a midget variable has a range of 10–365µµf.

R1—4,700 ohms, 1/2 watt
R2—470,000 ohms, 1/2 watt
C1—10-365 µµf, midget variable (Lafayette MS-27 or equivalent)
C2—.005 µf, ceramic
D—IN295, IN34, IN51 or equivalent
J1, 2—tip jacks, red
J3—tip jack, black
L—ferrite antenna (Lafayette MS-272 or equivalent)
Knob
Plastic box, 2 7/8 x 2 x 1 inch
Miscellaneous hardware

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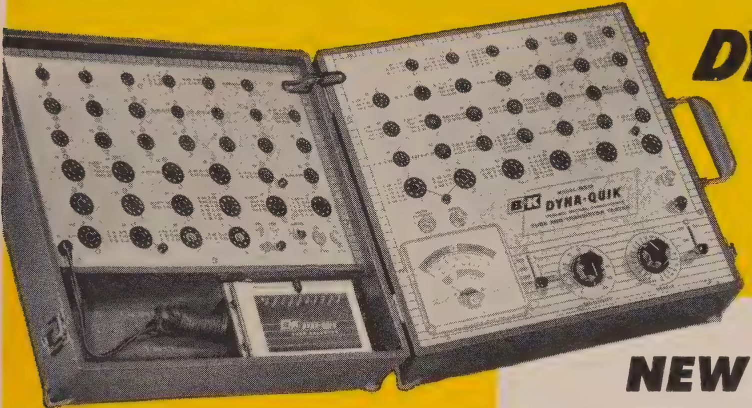

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Compact and easily built, this is a useful addition to any scope

TIME BASE Marker Generator

By JAMES G. ARNOLD

A TIME-BASE marker generator can be utilized in many ways with any oscilloscope. The measurement of rise and decay times of waveforms is probably its greatest application.

Users of moderate-priced scopes know that the calibration of their sweep-frequency controls is at best only a rough approximation. The sweep generator of the oscilloscope is designed to allow the synchronizing voltage to control the sweep frequency. These facts make a means for measuring time (or frequency) on a scope highly desirable. A simple, low-cost unit which is adaptable as a modification for any scope is offered as an answer to this need.

Several methods are used to measure time on the oscilloscope screen in the more expensive instruments. One uses a closely controlled sweep circuit. The associated sweep controls are calibrated in units of time (microseconds). Another compares the waveform under observation with a sine wave of known frequency. The first method requires very complex and extensive circuitry as well as closely controlled voltages. The second is awkward since the signal must be switched off the vertical channel and the sine wave substituted. The time-base marker generator described here is a good compromise between these methods. Essentially, the observed waveform is compared with a signal of known frequency, but the signal of known frequency is applied to the intensity grid of the cathode-ray tube rather than the vertical plates. This allows the waveform under observation to remain on the screen while the time-base marker is on.

The purpose of the time-base marker generator is to produce a train of pulses in synchronization with the oscilloscope sweep voltage. Marker pulses are spaced 1-μsec apart and are used to blank out the trace at this interval. This results in the trace seen in Fig. 1. Time measurements on pulses and other waveforms are made by counting the number of dots between any two points on the waveform. See Fig. 2.

Generator operation

The generator circuit is shown in Fig. 3. The sweep voltage of the scope (Fig. 4-a) is fed to the input of V1. Input amplifier V1-a is adjusted to have the proper amplitude output. This adjustment will be discussed later. The output waveform (Fig. 4-b) is fed to the grid of the damper (V1-b). The dc bias on V1-b is sufficiently below cutoff (E_{co}) to keep the tube cut off until it is brought out of cutoff by the positive-going sweep voltage. When V1-b is cut off, the 1-mc oscillator V2-a oscillates freely. But, when V1-b conducts, the grid coil of the 1-mc oscillator is effectively shorted and no signal is fed back to the grid of V2-a. Thus the oscillator is allowed to oscillate only while the grid

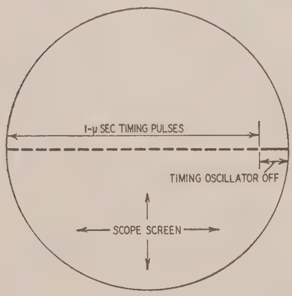


Fig. 1—How the generator affects the oscilloscope trace.

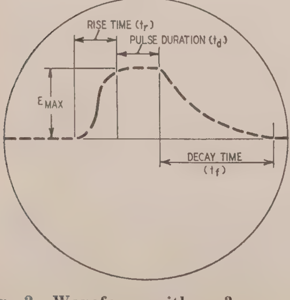
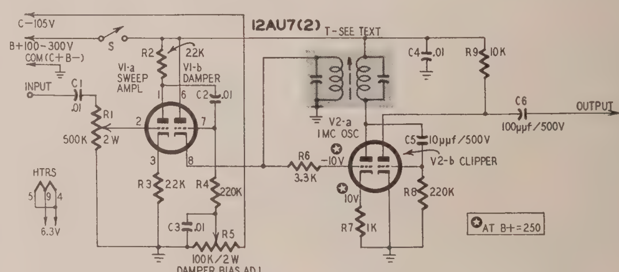


Fig. 2—Waveform with a 3-μsec rise time and 8-μsec decay time.



R1—pot, 500,000 ohms, 2 watts
R2, 3—22,000 ohms
R4, 8—220,000 ohms
R5—pot, 100,000 ohms, 2 watts
R6—3,300 ohms
R7—1,000 ohms
R9—10,000 ohms
All resistors ½ watt, 10%, unless noted

C1, 2, 3, 4—.01 μf, 500 volts, ceramic
C5—10 μμf, 500 volts, mica
C6—100 μμf, 500 volts, mica
S—Spst toggle switch
T—1-mc tuned transformer (see text)
V1, 2—12AU7
Small chassis
Sockets—(2) 9-pin miniature, shielded
Miscellaneous hardware

Fig. 3—Circuit of the time-base marker generator.

of V1-b is held below cutoff. The oscillator output is shown in Fig. 4-c.

The output of V2-a is fed to the grid of the clipper V2-b. The signal causes this grid to draw enough current to self-bias itself. Thus only the positive peaks of the grid signal are above cutoff (Fig. 4-d) and V2-b conducts only during these peaks. The resulting output is a train of negative pulses (Fig. 4-e). Each pulse corresponds to the positive peak of a cycle of the 1-mc oscillator and therefore the pulses are spaced 1-μsec apart.

If this train of pulses is fed to the intensity grid of the C-R tube, a blanked interval will occur in the tube trace for each microsecond pulse.

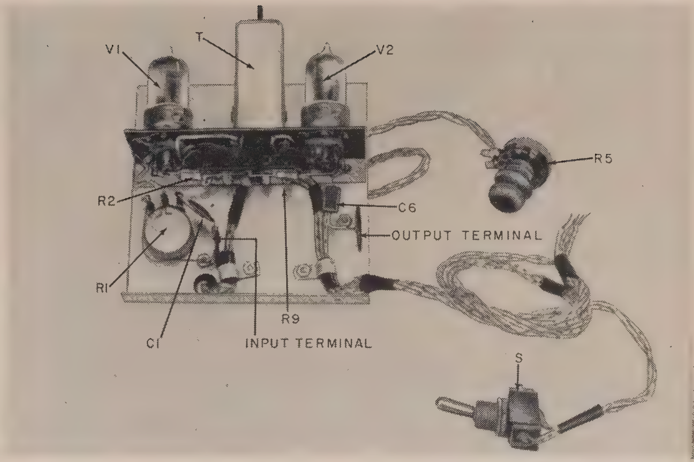
To have a series of 1-μsec dots appear on the screen, each pulse must occur exactly where a pulse occurred on the previous sweep. This means that, regardless of the sweep frequency, the first 1-mc pulse of each sweep must occur at the same distance from the beginning of the sweep. This is accomplished by damping out the oscillator near the end of the sweep. The oscillator is then shocked back into oscillation at the beginning of the sweep by the retrace voltage (the vertical portion of the sawtooth sweep). In Fig. 4-b the damper tube bias is adjusted so that the damper is above cutoff for approximately half of the sweep period. Thus, the oscillator is on for only half the sweep length. It is not necessary to hold the oscillator off for any great length of time. The bias on V1-b is usually adjusted until a line of well defined dots extends across the screen from the extreme left to within a short distance from the right edge as in Fig. 1. A pulse is shown being displayed on this trace in Fig. 2.

Construction techniques

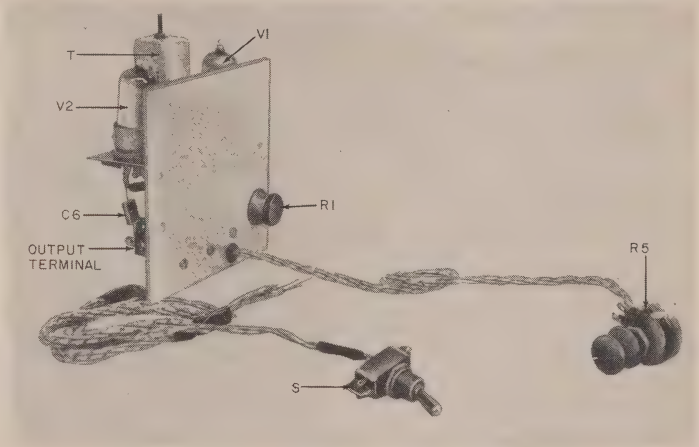
All parts are standard catalog items and are widely available with the exception of the 1-mc tuned transformer. This can be made by stripping down the windings of a standard 455-kc if transformer. The turns of each winding should be removed until the coil resonates at 1 mc with 150–200 μμf in parallel with each winding, giving the proper L-C ratio. This can be accomplished quite readily with the aid of a grid-dip meter. The parallel capacitors are then permanently mounted on the coil. A slug-tuned if transformer is preferable.

After wiring the generator and connecting the voltage supply, adjust the oscillator by placing the antenna of a shortwave receiver near the tube. Allow the oscillator to run freely by adjusting R5 for maximum bias voltage (− 105), Tune the 1-mc transformer to a zero beat with WWV at 5 mc. This is the fifth harmonic of the oscillator. If it does not oscillate, reverse the connections of the grid winding.

The unit was constructed on a subchassis and mounted on the oscilloscope chassis after completion. The generator can be built on a small subchassis and mounted in a position on the scope



Rear view of marker generator.



The time-base marker generator. Note its small size.

where there is some unused space. The B-plus, filament and bias leads are twisted into a neat cable and dressed along the edge of the chassis, terminating at the power supply of the scope. The B-plus lead was brought out to a front-panel spst switch to provide an on–off switch for the generator.

Potentiometer R5 is also brought out to the scope's front panel. Since this potentiometer controls only the dc bias of V1-b, its lead length does not affect the operation of the generator. Using R5 as a panel control will allow optimum operation of the time-base marker generator, regardless of sweep width.

A suitable power suppy is shown in Fig. 5. The time-base marker can be used with any positive voltage from 100 to 300 dc. The unit draws about 10 ma. It is usually feasible to obtain this voltage from the scope's power supply. The negative voltage can also be taken from the scope's supply if it uses a negative supply. One ma is required for the negative voltage. In

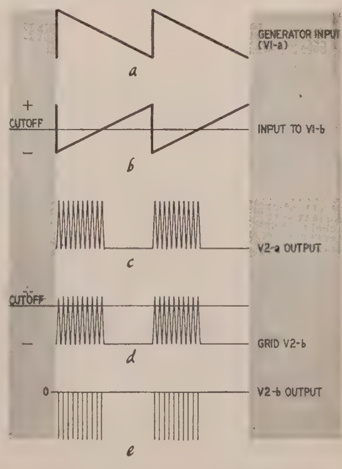


Fig. 4—Waveforms at various points in the generator.

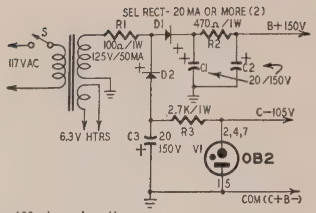
the power supply (Fig. 5) either positive or negative portions may be eliminated if you desire to take either of these voltages from some existing supply.

The input is connected to the plate of the sweep amplifier or to one of the horizontal deflection plates of the C-R tube. On a 5BP1-A tube, pin 6 usually has the correct polarity. The proper connection can be determined when making final adjustments.

The output connection is shown in Fig. 6, the common arrangement of the high-voltage circuit in the majority of oscilloscopes. Components C and R are usually provided on scopes with Z-axis modulation or blanking. If they do not exist on the oscilloscope, they may be added. A good value for R is 470,000 ohms, ½ watt. Its value is not critical. C may be any value greater than 50 $\mu\mu$f, but it must have a voltage rating greater than the high voltage of the oscilloscope plus the B-plus voltage of the time-base marker generator. Take care to cut off all voltages and discharge the scope's high-voltage capacitors before making this connection.

Final adjustments

After the unit is connected and mounted, final adjustments are made. Set the sweep width of the oscilloscope to just cover the entire screen. With the bias control R5 set for 0 volts, adjust R1 to the point where half the trace is covered with marker dots. If the marker dots appear on the left side of the screen, the adjustment is correct. If they appear on the right side, the input signal should be taken from the opposite deflection plate. If the scope does not have a push-pull sweep circuit (one deflection plate is grounded), it is necessary to reverse the signal polarity by disconnecting C2 from the plate of V1-a and connecting it to the cathode. The same procedure is used for adjusting the signal input to the point where half the screen is covered



R1—100 ohms, 1 watt
R2—470 ohms, 1 watt
R3—2,700 ohms, 1 watt
C1, 2, 3—20 μf, 150 volts
D1, 2—20-ma selenium rectifier (Federal 1159 or equivalent)
S—Spst toggle switch
T—Power transformer, primary 117 volts; secondary 125 volts, 50 ma, 6.3 volts, 2 amp (Stancor PA-8421 or equivalent)
V1—OB2, voltage regulator

Fig. 5—Power supply for the time-base marker generator.

with marker dots. When the adjustments are completed, the unit is ready for use.

In optimizing the marker generator for any particular sweep width, potentiometer R5 is turned past the point where all the trace is covered with dots. This increases the bias on V1-b. This bias is increased to the point just before the dots begin to blur. (When the dots blur, the oscillator is not being interrupted sufficiently to start oscillating at the same point on each sweep.) This will produce a well defined series of marker dots. By counting the dots between any two points on the trace, the time between these two points is measured. The number of dots seen on the scope is equal to the number of microseconds.

Possibly the most basic application of a time-base marker is that of frequency measurement. With a sine-wave on the oscilloscope screen, the time-base marker dots are counted across any complete cycle of the sine wave under measurement. This is the time period of one full cycle of the sine wave. The frequency can then be found by the formula:

$$f = \frac{1,000,000}{t}$$

where t is the number of marker dots counted and f the frequency in cycles per second.

An excellent application for a time-base marker is found in testing amplifier response with a square-wave generator. Normally the square-wave method gives only an indication of "good" or "poor" response. By using the time-base marker, the actual high-frequency

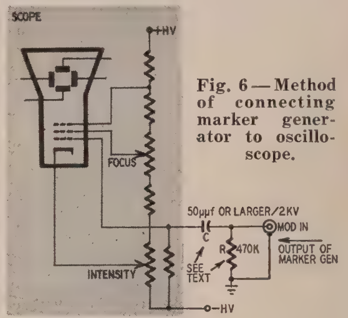


Fig. 6—Method of connecting marker generator to oscilloscope.

response can be determined. Count the number of dots that occur while the square wave rises from zero to 63% of its peak value. Then use the formula:

$$f_o = \frac{159,000}{t}$$

where t is the number of dots counted and f_o the high-frequency 3-db point in cycles per second.

TV receiver servicing can be aided by a time-base marker—waveforms may be truly checked rather than "just looked at." To the experimenter, a time-base marker is indispensible in any waveform applications. Serious photographers can use the instrument and a scope to measure the peak and duration of light from various types of photoflash lamps and to check the shutter action and accuracy at different speed settings. END

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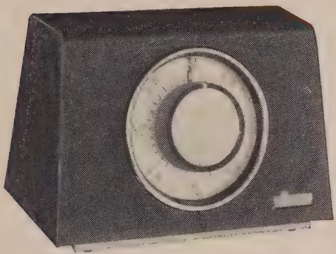

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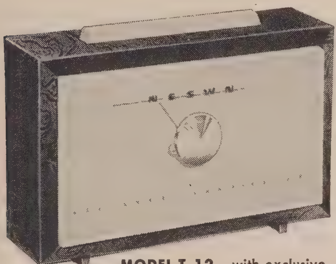

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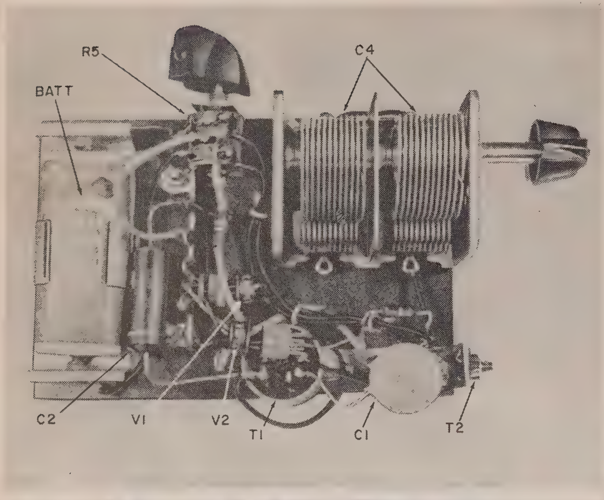
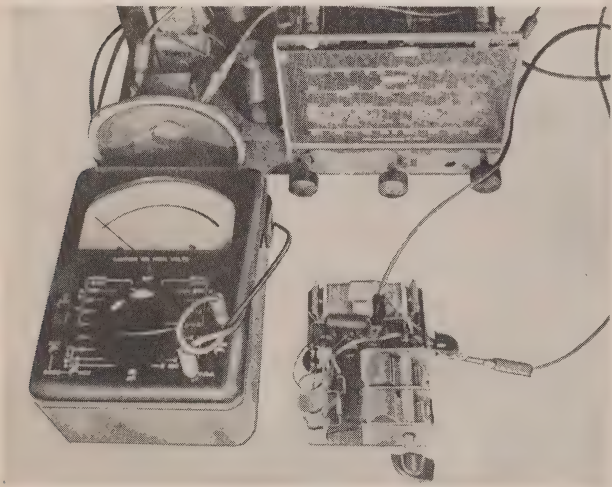
2-TRANSISTOR SIGNAL GENERATOR

Portable unit operates over broadcast band—can be used for intercom work

By JOSEPH CHERNOF





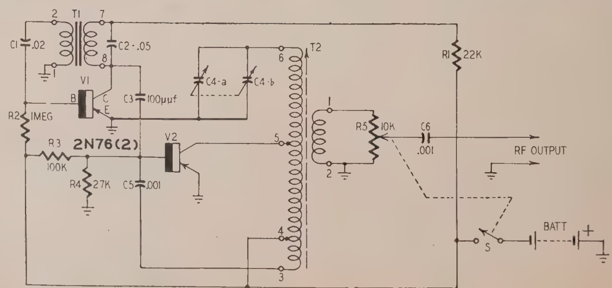
Top—Components layout of signal generator.
Bottom—Checking receiver with signal generator.

A POCKET-SIZED signal generator is a handy gadget for any electronic lab or workshop. This transistorized unit (see diagram) covers the entire broadcast band (550–1700 kc), has a self-contained source of audio modulation and makes a useful signal generator for working in the field. It can also be used as a low-power transmitter for broadcasting through home radios or as part of a transistor intercom installation when fed by a suitable microphone. The generator draws only 2 ma from a 30-volt B battery, yet puts out a minimum of 3 volts rf throughout its tuning range.

G-E 2N76 p-n-p junction transistors are used in both the rf and af oscillator stages since a number of these units gave very consistent performance in this circuit. Using an rf transistor such as the G-E 2N78, with the proper coil and capacitor combination, would extend the tuning range of the unit to about 5 mc.

Feedback necessary to sustain rf oscillation with transistor V2 is provided through tapped windings on T2, a special transistor oscillator coil de-

Parts for transistorized signal generator
R1—22,000 ohms
R2—1 megohm
R3—100,000 ohms
R4—27,000 ohms
R5—10,000-ohm pot., miniature, with spst switch
All fixed resistors ½ watt, 10%
C1—.02 µf
C2—.05 µf
C3—100 µµf
C4—2-gang tuning capacitor, 10–365 µµf
C5, C6—.001 µf
BATT—30-volt miniature B battery (Eveready 413 or equivalent)
V1, V2—2N76 transistors
T1—miniature interstage audio transformer; primary resistance 15,000 ohms, secondary impedance 95,000 ohms (UTC O-7 Ouncer or equivalent)
T2—transistor oscillator coil, Miller 2023
S—spst switch on R5
Transistor sockets (2)
Battery holder
Phenolic sheet, ⅛ inch, approximately 3 x 4 inches
Knobs (2)



Schematic diagram of transistorized signal generator—has af and rf oscillators.

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You will receive training for the Novice, Technician and General Classes of F.C.C. Radio Amateur Licenses. You will build 16 Receiver, Transmitter, Code Oscillator, Signal Tracer and Signal Injector circuits, and learn how to operate them. You will receive an excellent background for Television.

Absolutely no previous knowledge of radio or science is required. The "Edu-Kit" is the product of many years of teaching and engineering experience. The "Edu-Kit" will provide you with a basic education in Electronics and Radio, worth many times the complete price of $22.95. The Signal Tracer alone is worth more than the price of the entire Kit.

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You do not need the slightest background in radio or science. Whether you are interested in Radio & Electronics because you want an interesting hobby, a well paying business or a job with a future, you will find the "Edu-Kit" a worth-while investment.

Many thousands of individuals of all ages and backgrounds have successfully used the "Edu-Kit" in more than 79 countries of the world. The "Edu-Kit" has been carefully designed, step by step, so that you cannot make a mistake. The "Edu-Kit" allows you to teach yourself at your own rate. No instructor is necessary.

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The Progressive Radio "Edu-Kit" is the foremost educational radio kit in the world, and is universally accepted as the standard in the field of electronics training. The "Edu-Kit" uses the modern educational principle of "Learn by Doing." Therefore you construct, learn schematics, study theory, practice trouble-shooting—all in a closely integrated program designed to provide an easily-learned, thorough and interesting background in radio.

You begin by examining the various radio parts of the "Edu-Kit." You then learn the function, theory and wiring of these parts. Then you build a simple radio. With this first set you will enjoy listening to regular broadcast stations, learn theory, practice testing and trouble-shooting. Then you build a more advanced radio, learn more advanced theory and techniques. Gradually, in a progressive manner, and at your own rate, you will find yourself constructing more advanced multi-tube radio circuits, and doing work like a professional Radio Technician.

Included in the "Edu-Kit" course are sixteen Receiver, Transmitter, Code Oscillator, Signal Tracer, and Signal Injector circuits. These are not unprofessional "breadboard" experiments, but genuine radio circuits, constructed by means of professional wiring and soldering on metal chassis, plus the new method of radio construction known as "Printed Circuitry." These circuits operate on your regular AC or DC house current.

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FROM OUR MAIL BAG

Ben Valerio, P .O. Box 21, Magna, Utah: "The Edu-Kits are wonderful. Here I am sending you the questions and also the answers for them. I have been in Radio for the last seven years, but like to work with Radio Kits, and like to build Radio Testing Equipment. I enjoyed every minute I worked with the different kits; the Signal Tracer works fine. Also like to let you know that I feel proud of becoming a member of your Radio-TV Club."

Robert L. Shuff, 1534 Monroe Ave., Huntington, W. Va.: "Thought I would drop you a few lines to say that I received my Edu-Kit, and was really amazed that such a bargain can be had at such a low price. I have already started repairing radios and phonographs. My friends were really surprised to see me get into the swing of it so quickly. The Troubleshooting Tester that comes with the Kit is really swell, and finds the trouble, if there is any to be found."

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PROGRESSIVE "EDU-KITS", INC.

497 Union Ave., Dept. 134G, Brooklyn 11, N. Y.

signed by J. W. Miller to provide proper impedance and phase relationships for optimum performance with transistor circuits. The primary of T2 is tuned by C4-a and C4-b, a two-gang standard broadcast-band tuning capacitor with both sections connected in parallel. A second tuning adjustment is provided by the adjustable ferrite core in T2. However, it was found that with the core adjustment on T2 screwed in about as far as it would go, C4-a and C4-b were adequate to cover the entire broadcast band.

Resistors R3 and R4 supply the proper dc bias to the base of V2, and C5 provides dc isolation while at the same time feeding rf energy back. Resistor R5, a miniature Clarostat potentiometer and switch assembly, serves as the rf output control, and C6 as rf output capacitor.

Feedback for af oscillator transistor V1 is provided by transformer T1, a UTC O-7. Almost any interstage type transformer with about a 3-to-1 turns ratio could be used as long as the higher-impedance winding goes to the collector of V1 and the lower-impedance winding to the base. Base bias for V1, supplied by R2 and R1, reduces total current drain of the stage to an extremely low figure.

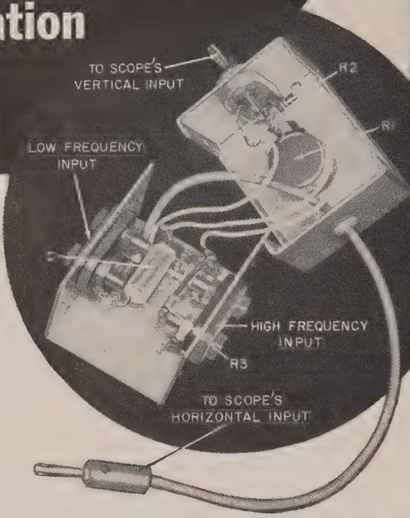
With C2 connected across the secondary of T1 this circuit oscillates at about 5,000 cycles. A larger transformer with more inductance in the windings would lower this frequency considerably and C2 could probably be eliminated. The af output of V1 is coupled to the base of V2 through C3, producing fairly clean modulation of the rf carrier.

The 30-volt miniature B battery is mounted in a miniature battery holder now available commercially. Both 2N76 transistors are plugged into standard transistor sockets. This type of installation is preferable to making direct soldered connections to the transistor leads, risking damage by overheating.

The entire unit is built up on a 1/8-inch-thick phenolic block, 3 inches wide and 4 inches long. The relatively large size of the tuning capacitor prevents using a smaller base. In transmitter or intercom applications V1 should be disabled. Then, fairly good voice modulation may be obtained by opening the connection to ground of the emitter element of V2 and inserting a carbon microphone in series.

The signal generator dial may be calibrated with the help of a home radio, by zero-beating its output against local broadcast stations of known frequency. Tune in a station around 600 kc and then, starting at the low-frequency end, tune the signal generator for a null between two whistles. Mark the dial with the station frequency. Repeat the operation on other stations every 20 kc or so across the broadcast band. The frequency stability of transistor oscillators is not exceptionally good so calibration should be rechecked frequently. END

phase-shift comparator measures frequency ratios, modulation



Add this attachment to your scope to measure audio frequencies. Also checks modulation percentages

Parts layout inside comparator.

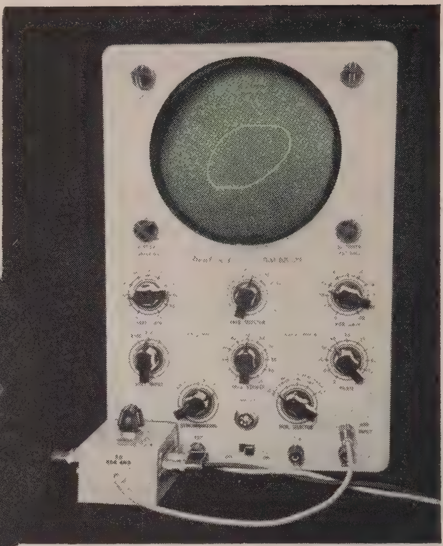
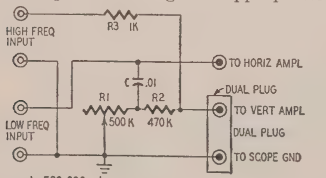


Fig. 2—Circular trace is obtained with comparator connected to a scope.

By J. E. PUGH, JR.

FREQUENCY comparison by the circular-trace method is very simple and permits accurate comparison of higher frequency ratios than possible with the conventional Lissajous-figure method.

In the circular-trace method, the lower frequency is used to generate a circle or ellipse on the oscilloscope by applying it to the horizontal and vertical amplifiers through an appropriate phase shifter. The higher frequency is applied to the vertical amplifier and appears as a modulation on the circle. Because the trace is circular, the forward and return portions of the pattern do not overlap as with Lissajous figures. Confusion is eliminated and comparison of very high frequency ratios is possible.



R1—pot, 500,000 ohms
R2—470,000 ohms, 1/2 watt
R3—1,000 ohms, 1/2 watt
C—.01 µf, 200 volts
Banana plugs, double, Millen 37212 (2)
Banana jacks, double, National FWJ (2)
Banana plugs, single, 3/4-inch stud, Johnson 108-75A (2)
Banana plug, insulated, single, red
Insulator, binding-post mount, double, National FWC
Bar knob, 1 1/4 inches for 1/4-inch shaft
Bakelite tie point, 2 terminals
Aluminum case, 1 5/8 x 2 1/8 x 2 3/4 inches, Fleximount
Red test prod wire, 0.140-inch diameter (10 feet)
Black test prod wire, 0.140-inch diameter (10 feet)
Insulated sleeve, 1/4 inch OD x 3/8 inch long
Miscellaneous hardware

Fig. 1—Circuit of phase-shift comparator.

Although the higher and lower (reference and unknown) frequencies are interchangeable as connected to the phase shifter, a more easily read oscilloscope pattern is obtained when the lower frequency is used to generate the circular trace. In most scopes the gain and high-frequency response of the horizontal amplifier are less than those of the vertical amplifier so the lower frequency is applied directly to the horizontal amplifier.

The phase shifter can also be used for measuring percentage of modulation of both carrier and modulation frequencies.

Comparator circuit

The comparator is easy to build and operate. It can simplify frequency comparison—such as oscillator calibration—immensely. It is designed to permit direct connection to the oscilloscope.

The basic phase shifter consists of C and R1 (Fig. 1) while resistors R2 and R3 isolate the higher-frequency generator from the lower-frequency generator and horizontal amplifier. Potentiometer R1 permits adjustment of the lower frequency's phase, as applied to the vertical amplifier. This allows the shape of the circular trace to be adjusted for best readability. C and R1 supply a usable phase shift from 20 cycles to about 1 mc. The low-frequency shift can be improved by increasing C to 0.1 µf—but at the expense of a smaller shift at the high-frequency end.

A 1 5/8 x 2 1/8 x 2 3/4-inch aluminum box houses the circuit. The layout is not critical, but clearance between parts must be watched as space is limited.

A double banana plug permits direct connection to the vertical amplifier terminals of the oscilloscope, and a single banana plug on a flexible lead connects to the horizontal amplifier. Both the reference and unknown frequencies are connected to the circuit through double banana plugs and jacks.

The double banana plug for connecting to the vertical amplifier is mounted on one end of the case. (To match the vertical input of your scope another type of connector may be needed. Just replace the double banana plug with a connector to match your scope.—*Editor*) It is made from a double binding-post insulator and two banana plugs with threaded mounting studs. The

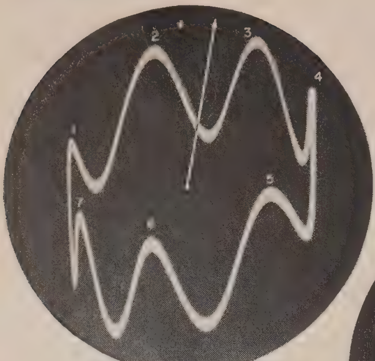


Fig. 3—Oscilloscope trace showing a frequency ratio of 7:1.

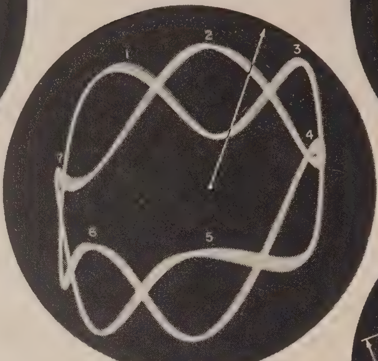


Fig. 4—Pattern seen with 7:2 frequency ratio.

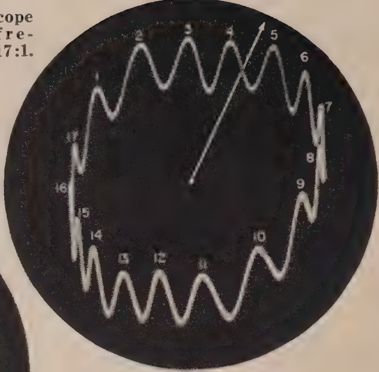


Fig. 5—This scope trace shows frequency ratio of 17:1.

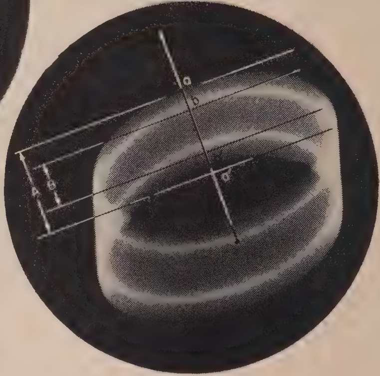


Fig. 7—Method of measuring percent of modulation from oscilloscope pattern.

threaded studs are smaller in diameter than the holes in the insulator and a $\frac{1}{4}$-inch-diameter $\frac{3}{8}$-inch-long sleeve is used to provide a good fit. The sleeve can be metal or fiber. The assembled plug is inserted in one of the double jacks before tightening the nuts to align the plugs correctly.

After construction is completed the individual plugs and jacks can be labeled with decals. The hot terminal of each plug and jack should be marked with a dab of red paint since they are not polarized.

How to use it

First insert the double banana plug of the comparator into the scope's vertical input terminals. Connect the single plug to the horizontal amplifier jack. If the reference frequency is the lower one—such as the 60-cycle power-line frequency or a variable low-frequency generator—connect it to the lower-frequency terminals.

Now attach the unknown-frequency generator to the higher-frequency terminals and reduce its output to zero. With the scope's sweep-selector switch set on external, adjust the comparator's phase control to give a circular sweep as illustrated in Fig. 2. The horizontal and vertical gain controls are adjusted to give a suitable size to the circle. Increase the output of the unknown-frequency generator until the circle is well modulated but avoid overlapping the upper and lower portions of the trace. See Figs. 3, 4, and 5 for this pattern.

Adjust the reference frequency until a stationary pattern is obtained and count the number of cycles on the circle. This is most easily done by counting the number of peaks—positive or negative. Then determine the number of lines cut by a radial line through the circle. This is shown in Fig. 4. The frequency ratio is now determined by:

$$\text{Ratio} = \frac{\text{number of cycles } (+ \text{ or } - \text{ peaks})}{\text{number of lines cut}}$$

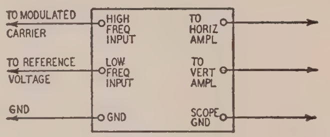


Fig. 6—Using comparator to measure percent of modulation.

In Fig. 3 the ratio is 7/1, in Fig. 4 it is 7/2 and in Fig. 5 it is 17/1.

When comparing frequencies over a wide range—when calibrating an audio signal generator with a 60-cycle reference frequency—it is not necessary to count cycles at each multiple of the reference frequency. Simply check the ratio at one of the lower multiples and add the reference frequency each time a stationary pattern with complete cycles (Figs. 3 and 5) is obtained.

For example, 60 would be added each time a stationary pattern of full cycles is obtained if the reference frequency is 60 cycles. An occasional count should be made to be sure that a multiple hasn't been missed.

It is possible to compare frequencies up to several megacycles. The upper limit is determined only by the frequency response of the oscilloscope amplifiers.

The percentage of modulation can be obtained by using a reference frequency much lower than the carrier frequency but higher than the modulation frequency. Connections to the comparator are shown in Fig. 6. This will give a pattern as shown in Fig. 7. This makes possible a very simple percent-of-modulation measurement without requiring a connection to the modulation voltage.

By connecting the modulated carrier to the high-frequency terminal and the modulation voltage to the low-frequency terminal a pattern similar to the familiar trapezoid is obtained.

In either case the voltages will have to be about the same amplitude as when making modulation measurements using conventional methods.

In Fig. 7 the percent of modulation is 30 and is obtained by:

$$\% \text{ modulation} = \frac{A - B}{A + B} \times 100.$$

When the reference frequency is equal to or less than the modulation frequency, the area between a and b will appear as a number of alternations. The shape of these alternations will depend on the shapes of the reference and modulation voltages and the number of cycles on their frequency ratio.

If the reference frequency is increased until it nears the carrier frequency, waves extending the entire width of the ring (from a to a′) will begin to appear. The number of complete cycles will indicate the carrier to reference frequency ratio. END

new Records MONITOR

***Note:** Records below are 12-inch LP and play back with RIAA curve unless otherwise indicated.*

IBERT: ***Divertissement***
FRANCAIS: ***Symphony for Strings***
Surinach conducting
MGM String and Chamber Orchestra
MGM E-3514

The recent Boston Pops recording of the *Divertissement*, which I liked very much, is a full-scale orchestral transcription. This is the original scoring for a smaller chamber orchestra and the effect is possibly even more amusing. The greater intimacy of the smaller group and the excellent presence produce a fine effect in the living room. The Francais symphony is a seldom-heard work which most listeners should find interesting, pleasant and restful. The string bass on both sides is outstanding. Some pickups may be slightly overdriven on the peaks.

COBERT/LANG: ***Frankie and Johnny***
Special cast and orchestra
MGM E-3499

This is another first performance of a dramatic musical but of a very different color. Based on the tale told in the classic jazz song *Frankie and Johnny*, it is billed as a legend in two acts. This presents the songs from the two acts as they had been performed on Broadway. I commend it to other companies as evidence that a Broadway type show can be recorded reasonably cleanly, with a minimum of overcutting, good tonal balance and fine sound.

Calypso Jazz Sampler
Cook XX-2

Another Cook sampler, this one with 14 selections from 9 of Cook's Caribbean albums, including at least one of all the various local types from pure calypso to steel band, recorded on the scene, pressed by Microfusion and packaged in sealed, flexible, transparent plastic cases. Typical Cook quality with tremendous presence and a wide variety of high, middle and bass, test and showoff material. The maracas high highs are especially impressive on equipment with a fine transient and high end response. The bass is live and different.

Folk Music Festival (Songs and Dances of Kazakhstan, Kirghizia, Georgia and Moldavia)
Various artists
Westminster WP-6055

Some 18 samples of folksongs of Russia in performances and recordings which are both rather amateur in quality but with on-the-very-spot authenticity. The master tapes are Russian and recorded (but clearly not by Emory Cook) in the various provinces with indiginous performers. As for the songs and dances, they should be of interest not only to the folksong specialists but to the ordinary listener as well and would enliven a hi-fi concert nicely. Most of them have an "I played fiddle for the Czar" pattern, but some resemble Spanish flamenca more than anything else and others have definitely Oriental elements.

Bach on the Biggest
Robert Elmore on Organ of Atlantic City Convention Hall
Mercury MG-50127

Bach buffs will be rebuffed by the very title and idea, but those who like their sound bigger and louder will find here a noteworthy experience, especially in big pedal bass and one of the longest reverberation periods on records. Actu-

ally Elmore is not irreverent and the reverberation doesn't do mayhem to Bach. Mercury engineers deserve great credit since the proper placement of a mike or mikes must have presented a headache in keeping with the monumental size of both building and organ.

Fiesta for Pipe Organ
With Rhythm Accompaniment
Alfred Mendez, Organist
RCA Victor LPM-1444

And now mambos, cha-cha-chas and other Latin musical tid-bits on the organ with a rhythm backing—a combination that is possible only with the help of multiple miking and electronic reproduction. Anyhow, the combination of a fair pedal and sharp Latin style high highs is most individual and provides a unique hi-fi potpourri. Very clean and sharp.

Fingers on Fire
Arthur Smith and His Cracker-Jacks
MGM E-3525

Arthur Smith is the hill-billy virtuoso of the Carolinas radio and TV stations who is billed as "the world's greatest guitar player" and here doubles on banjo, fiddle, mandolin and accordion in a dozen of his biggest hits, including *Listen to the Mocking Bird, Yes, Sir, That's My Baby, Chicken Strut, Freeze it Boogie,* etc. Before you contest the claim, you'll do well to listen to this. Notable hi-fi-wise for the very fine reproduction of the plucked instruments and the novel effects Arthur achieves, including clucking of chickens, chirping of birds, etc. And a far better recording than pop music usually receives.

A Night at Poppa John's
Pappa John Gordy, Piano with Various Backing
RCA Victor LPM-1424

Here's more pop recorded cleanly and with high presence and notably sharp highs. Poppa plays ragtime with an infectious beat though not with the originality of Del Wood. Add this to the 1-foot shelf of really good pop recordings.

S. F. Record Tid-Bits
San Francisco M-33012

This is a sampler of this label's complete catalog, but it is also an excellent review of the evolution of popular music from the nineties to the present, plus a sampling of mechanical music-makers such as the old player pianos and cylinder phonographs. The recording technique is top-notch—in the audiophile class—and presents some brilliant hi-fi material with very sharp, clean highs and a notable drum in the Guckenheimer Band selection. The most unusual of all the samplers and sure to delight any hi-fi party. Warning: the selection from the Naughty Nineties really is; don't play this for the maiden aunt except with forethought.

Hi-Fi Sounds for Hounds
San Francisco M-33009

If you have a really first-class system, particularly a pickup and speakers with a superb high end and transient response, this will deliver realism that will shame two-channel stereo. The bass drum on band 3 of the first side is most real, the roller-coaster ride has a terrific assortment of astonishingly clean mid-frequency transients. Among other novelties are a jug band, a one-man band, the surf of the Pacific and the best-yet reproductions of a tremendous orchestrion type nickelodeon. Guaranteed to please on any system and positively astonish on the best.

The Orchestra
Stokowski
Capitol SAL-8385

It is becoming more and more difficult to think of something original in the way of demonstration records, but Capitol has managed the trick in this, which presents a fine orchestra under Stokowski playing eight works—first, the several sections of the orchestra alone and then in various combinations. The percussion section, Section I of Farberman's *Evolution,* is particularly impressive, but the entire recording yields very impressive sound with excellent definition despite the use of a very live hall or studio. The recording is free of any audible distortion when the best pickups are used. Hi-fi fans will find

NEW RECORDS *(Continued)*

this both instructive and very impressive on good systems. But the *Gates of Kiev* is not nearly as spectacular as its Toscanini recording (RCA Victor LM-1838, Moussorgsky's *Pictures at an Exhibition*).

TCHAIKOVSKY: *Symphony No. 4*
Scherchen conducting Vienna State Opera Orchestra
Westminster XWN-18522

I know of no symphony better suited for hi-fi demonstration than this with its brassy peaks, procession of instruments in solo passages, excellent drums and tremendous dynamic range. And both Scherchen and Westminster do it complete justice in this recording which presents both the crescendos and diminuendos with great clarity and cleanness. The balance is especially good and even at moderate volume it yields a fine illusion of actual performance. The recording, on the dead side, yields superior definition and yet, played back in a fair-sized living room, it delivers a just-right liveness. An outstanding example of modern high-fidelity recording with no exaggeration but a high degree of verisimilitude.

Munch Conducts Wagner
Boston Symphony Orchestra
RCA Victor LM-2119

Another sampling of Wagner's music in orchestral suites—*Overture and Venusberg* from *Tannhauser*, *Magic Fire Music*, and *Siegfried's Rhine Journey*—in a suitably spirited performance by this superb orchestra whose choirs are as true as chords on a well-tuned piano. The recording is up to the very high quality so usual in RCA's discs of this orchestra, and extremely clean even in the very big peaks. Plenty of brass, high highs, good bass and fair percussion for splendid showoff—especially the middle of the first side.

IBERT: *Capriccio*
Divertissement
Suite Elizabethaine
Winterthur and Vienna Symphonies
Westminster XWN-18520

The Divertissement is deservedly popular for its satiric humor; the other two are less often played and in a more serious vein. Together they give a good review of Ibert's range of styles, which can go from baroque to jazz. The recording is especially fine with excellent definition and is perfectly clean.

Band Music of HM Irish Guard Band
RCA Victor LM-2020

A fine variety of 14 concert pieces ranging from the *Irish Washerwoman* to *The Dance of the Tumblers*—many of which are in the repertoire of our best high-school bands—brilliantly played by the band of Her Majesty's Irish Guards. High-school band leaders should have a copy by all means, but the ordinary hi-fi listener will enjoy it, too. One of the very best brass-band recordings with excellent balance, a high degree of presence and good drum in spots.

Hi-Fi à La Espanola
Fennel conducting Eastman-Rochester Pops Orchestra
Mercury MG-50144

Ten Spanish classics from *Andalusia* and *Malaguena* to *Goyescas* and *The Ritual Fire Dance* from *The Three Cornered Hat* recorded with a very Olympian sound. The drums, especially, will delight everybody but particularly owners of big speaker systems. There are plenty of Latin high highs to try the tweeters, and the dynamic range will try everything from pickups to speakers. Should become very popular as a demonstration and showoff record, for few records deliver both ends as spectacularly.

SCHUBERT: *Octet in F Major*
Vienna Concerthaus Quartet plus Winds and Double Bass
Westminster XWN-18471

I have often remarked how much more real a chamber group sounds in the typical living room than does a big orchestra. Here is another very notable case in point. This is a quartet augmented by a double bass, clarinet, bassoon

NEW RECORDS *(Continued)*

and French horn in a superb example of octet music. The definition, purity of tone and cleanness of this recording can produce an illusion of presence so complete that the difference would be mere quibbling. The biggest difference is in the low level of the double bass.

CHAIKIN: *Concerto for Accordion*
SHASHAKOV: *Concerto for Balalaika*
GORODOVSKAYA:
Suite for Folk Orchestra
VITOLYN: *Village Polka*
Various Russian Orchestras
Westminster XWN-18464

Those who like samplings of strange and novel instruments and different music should get hold of this—one of the best recordings from a sound quality viewpoint to come from the USSR, though not up to Westminster's own best. The accordion concerto is the more classical both in composition and orchestration; the others are definitely folksy in character. All of it is pleasant and obviously Russian.

KENNAN: *Three Pieces for Orchestra*
BERGSMA:
Gold and the Senor Commandante
BERNARD ROGERS:
Once Upon a Time
Hanson conducting Eastman-Rochester Orchestra
Mercury MG-50147

Three examples of programmatic music by three contemporary Americans in the spectacular Olympian recording technique with lots of tremendous drums and bass, but likely to overload even the finest pickups in the peaks. The music is not likely to be remembered long, but is not unpleasant. *Once Upon a Time* has a real charm, as well as some fine high percussives and a final movement with big, low-down drums galore.

BACH: *Sonata No. 2*
Partita No. 3
Jascha Heifetz . .
RCA Victor LM-2115

Two of the most remarkable—and difficult—works for the violin in magnificent performances by one of the greatest virtuosi, recorded close up to reveal to a knowing ear the technique of fingering and with one of the cleanest and loveliest violin tones on records. I can think of no finer present for a violin student who also owns a good hi-fi, but anyone who loves the fiddle should be extremely pleased with it.

Curtain Going Up
Fiedler and Boston Pops
RCA Victor LM-2093

Pleasant orchestral potpourri of the principal tunes from six recent Broadway shows: *My Fair Lady, Carousel, Brigadoon, South Pacific, Wonderful Town* and *Can-Can,* plus a medley of Rogers waltzes. Not remarkable from a hi-fi point of view but clean and bright and free of the overcut distortion most show recordings are guilty of.

BEETHOVEN:
"Emperor" Piano Concerto (No. 5)
Solomon, pianist
Menges conducting Philharmonia Orchestra
RCA Victor LM-2108

Horowitz in Recital
Selections from Public Performances
RCA Victor LM-1957

BEETHOVEN:
Piano Sonata No. 17 (Tempest)
CHOPIN: *Etudes 1, 5 and 8*
Mazurka in A
Scherzo in C Sharp Minor
Dorothy Eustis
Alta Records 1001

About as useful a measure of very fine hi-fi systems as I know of is the reproduction of various pianos. The piano still remains the most difficult single instrument to record and reproduce faithfully, for it takes a superb combina-

tion of transient response, dynamic range and freedom from wow and hangover to do an adequate job. Furthermore, both pianos themselves and the technique of playing them are so highly individual that no two pianos sound exactly alike, even when played by the same person. Hence, system quality can be judged by the degree to which the differences are revealed; the better the recording and system, the more distinct each piano recording.

Here are three cases in point. The Horowitz, which is a collection of recordings made over several years, is especially good for the purpose, presenting a variety of piano tones and recording quality (some of it quite poor). It provides, also, a fine sampling of the technique of an acknowledged modern virtuoso. Horowitz playing *The Stars and Stripes Forever* alone is worth the price.

The Emporer is one of the greatest of piano concerti and receives here a recording brilliant in sound and quite representative of today's piano recording technique.

The Dorothy Eustis on a new label represents a successful attempt to do better by the piano than the ordinary disc manages to do. Recorded at a lower average level and without limiters, it is very clean, though one or two peaks may overdrive some pickups. Given a turntable without much wow, the piano is very true and sharp. The pressing is by the Microfusion process.

Fritz Kreisler Favorites
Rafael Druian, violin

Mercury MG-50119

A baker's dozen of Kreisler compositions, including *Caprice Viennoise, Old Refrain, Liebesleid, Tambourine Chinois* and six of the famous "hoax" pieces he ascribed to 18th and 19th century masters. I suppose many would prefer to have actual Kreisler performances, but Druian, concertmeister of the Minneapolis Symphony, performs them with faithful sentimentality and a beautiful fiddle tone free of edginess except in one or two peaks where some pickups may be overdriven or tweeters found wanting.

SURINACH: *Concerto for Piano, Strings and Cymbals*
MARGA RICHTER: *Concerto for Piano, Violas, Cellos and Basses*
William Masselos, Piano
Surinach conducting MGM-String Orchestra

MGM E-3547

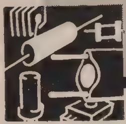
Both of these works are scarcely two years old. The Surinach is engagingly unusual both for its odd instrumentation and its combination of modern and Spanish feelings; it shouldn't take much musical sophistication to like it and the sound is very different. The piano is very fine and the cymbals deliver a surprising variety of effects. MGM has commendably held back its tendency to overcut on the Surinach side, but the Richter side will present trouble to many pickups, especially when the piano hits fff. It will not be easy to take except to those who like the modern idiom.

Last Call for Crazy Otto

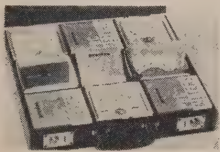
About two years ago Germany exported some Polydor discs called *Die Beschwipste Drahtkommode,* featuring as the artist *Der Schrage Otto,* who played a very schmaltzy ragtime piano with a rhythm backing. These laid the disc jockeys on their ears and for a while you will recall the air was full of Crazy Otto. There was a good reason for this, the recording was terrific, with high highs so sharp that they shamed our own 45-rpm pops and gave a real opportunity for AM and FM stations to show off their new hi-fi pickups. Later they were issued by an American label on 33 rpm. Now Radio Shack of Boston is disposing of the remainders of the original Polydors (three for $1) and I strongly recommend that the set be added to the library for demonstration as well as pleasure. They may also be available on other record bargain counters. There are three of them under the above title and Polydor numbers: 22,009, 22,041 and 22,253. END

Name and address of any manufacturer of records mentioned in this column may be obtained by writing Records, RADIO-ELECTRONICS, *154 West 14 St., New York 11, N.Y.*

new Devices

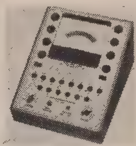


PDC METERS. Kits for constructing a large number of meters from a few foundation movements. Contain 6, 12 or 60 meter movements, related scale faces and companion resistors. Combining, meter movements with scale faces and resistors



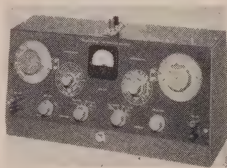
lets 6-movement kit (illustrated) make up almost 100 meters (dc voltmeters, micro- and milliammeters; ac voltmeters and milliammeters). 12-movement kit turns out more than 400 meters. 60-movement kit replaces stock of 2,000 meters.—**Precise Development Corp.,** 2 Neil Court, Oceanside, N. Y.

TUBE TESTER, *model 302.* Checks for shorts, leakage and



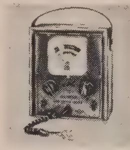
quality. Line-voltage regulation. With *PTA* adapter, checks and rejuvenates picture tubes. —**Electronic Measurements Corp.,** 625 Broadway, New York 13, N.Y.

IMPEDANCE BRIDGE KIT, *model 1B-2A.* Built-in power supply, 1,000-cycle generator and vacuum-tube detector. 100



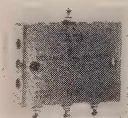
–0–100-μa meter for null indications. Measures resistance from 0.1 ohm–10 megohms, capacitance from 10 μμf–100 μf. inductance from 10 mh–100 h; dissipation factor from .002–1; Q from 0.1–1,000.–**Heath Co.,** 305 Territorial Rd., Benton Harbor, Mich.

TRANSISTOR TESTER, *model TT-2.* Checks current gain, leakage, opens, shorts and cutoff current of all transistors. Checks diodes for forward–reverse cur-



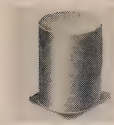
rent gain.—**Century Electronics Co. Inc.,** 111 Roosevelt Ave., Mineola, N. Y.

VOLTAGE DROPPER, *model RP-612.* Provides 6 volts from a



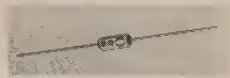
12-volt battery source. 4, 6 and 8-amp taps. 4⅛ x 3⅛ x 1 inch. —**Rue Products,** 1628 Venice Blvd., Venice, Calif.

TOROID COILS, for high-frequency applications. *MQD series.* Temperature-stabilized from −40°C to 85°C. 6 types ranging from 2–20 mh. Q of 170 at 50,000 cycles. Hermetically



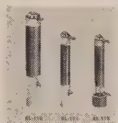
sealed. — **United Transformer Corp.,** 150 Varick St., New York 13, N. Y.

HIGH-FREQUENCY CHOKES. 4 ferrite-bead units. From 0.3–



1.3 μh with 30-mc ac resistance of 25–100 ohms. For use as filament chokes, parasitic suppressors and series elements of low-pass filters for frequencies of 5–200 mc.—**National Co. Inc.,** 61 Sherman St., Malden 48, Mass.

RF CHOKES. *RL-100, RL-101, RL-102, RL-110, RL-111* and *RL-112.* Medium- and high-power units in 3 mounting types. For frequencies 3.5–31 and 12–55 mc.

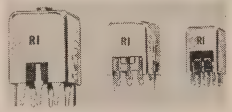


Raypar Inc., 7800 W. Addison St., Chicago 34, Ill.

CHOPPER INPUT TRANSFORMERS. Operate with signal levels of 0.1 μv with maximum transfer efficiency. Primaries

for use with either dc chopper-modulated or ac signals. Sealed in high-permeability shielded cans. — **James Vibrapowr Co.,** 4050 N. Rockwell St., Chicago 18, Ill.

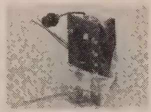
IF TRANSFORMERS. Three sizes: ¾, ½ and ⅜ inch. Printed-circuit (illustrated) and wired-circuit types. Built-in



shunt capacitors from 64–470 μμf. — **Radio Industries Inc.,** 5225 N. Ravenswood Ave., Chicago 40, Ill.

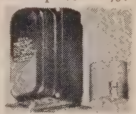
MINIATURE TRANSFORMERS, *Teenyformers.* 0.203 x 0.297 inch. 700 weigh less than a pound. For transistor applications. — **Gramer-Halldorson Transformer Corp.,** 2734 N. Pulaski Rd., Chicago 39, Ill.

FLYBACK REPLACEMENTS. *EFR 196* replaces Motorola 24K736488. *ERF 197* replaces



Motorola 24C736487. Packed in hermetically sealed plastic containers. — **Rogers Electronic Corp.,** 49 Bleecker St., New York 12, N. Y.

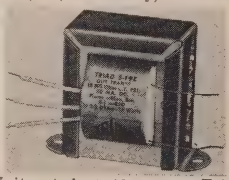
CONSTANT-VOLTAGE TRANSFORMERS, 5 models. Regulate 6.3-volt filament supply within 1% with line-voltage variations up to 15%. Regula-



tion automatic. Response time within 1.5 cycles. Current ratings of 5–25 amperes.—**Sola Electric Co.,** 4633 W. 16 St., Chicago 50, Ill.

REPLACEMENT UNITS. TV power transformers: *P-3064* replaces G-E RTP-314; *P-2847* Motorola 25C790864 and 25K791977; *P-2876* RCA 77635 and *P-3134* Zenith 95-1298. Filament transformers: *P-2864* replaces Philco 32-8574-1; *P-2848* Motorola 25B791793 and 25B700137 and *P2889* replaces Crosley 155532. Rf chokes: *BC-551,* 2.5 mh; *BC-552,* 5.0 mh, and *BC553,* 10 mh.—**Merit Coil & Transformer Corp.,** 4427 N. Clark St., Chicago 40, Ill.

OUTPUT TRANSFORMER, *model S-19Z.* Primary, 10,000 ohms, ct; secondary, 3.2 ohms.



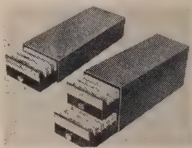
Unit rated at 10 watts.—**Triad Transformer Corp.,** 4055 Redwood Ave., Venice, Calif.

VIBRATORS, *Gold Label line.* Quiet operation. Buttonless con-

tact construction.—**P. R. Mallory & Co. Inc.,** 34 S. Gray St., Indianapolis, Ind.

PRECISION RESISTORS, *Rite-ohm series 77.* Metal film type. Axial or radial leads. 100–300,000 ohms, ¼ watt.—**Ohmite Manufacturing Co.,** 3661 Howard St., Skokie, Ill.

CAPACITOR KITS, ceramics. *CK-2* contains 150 most-needed disc ceramics in 2-drawer cabinet. *CK-3* has 75 most-needed

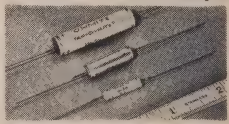


disc ceramics in 1-drawer cabinet, *CK-4* offers 3 each of 4 different Universal ceramic capacitors mounted on a heavy card folder.—**Sprague Products Co.,** 125 Marshall St., N. Adams, Mass.

CAPACITOR, *type RQL.* Mylar metallized in a hermetically sealed case. Reliable at temper-

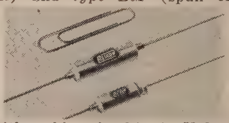
atures up to 125° without derating.—**Astron Corp.,** 225 Grant St., E. Newark, N. J.

ELECTROLYTIC CAPACITATORS, *Tan-O-Mite, series TF.* High-quality tantalum-foil units manufactured in limited quan-



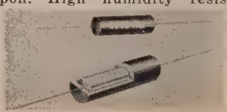
tities. 0.25–140 μf. Voltages up to 150.—**Ohmite Manufacturing Co.,** 3653 Howard Ave., Skokie, Ill.

SUBMINIATURE ELECTROLYTICS, *type EE* (Epoxy end fill) and *type EM* (spun end



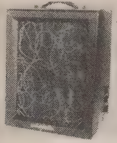
with rubber bushing). Voltage ratings of 1, 3, 6, 8, 16, 26 and 30. Size from 3/16 x ½ to ¼ x ¾ inches.—**Astron Corp.,** 255 Grant Ave., E. Newark, N. J.

CAPACITORS, *type 600-UE.* Mylar dielectric, molded in Epon. High humidity resist-



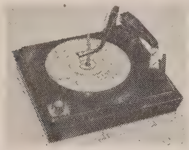
ance, high stability and low leakage. — **Good-All Electric Manufacturing Co.,** Ogallala, Neb.

HI-FI SOUND SYSTEM, *Audiotone.* Incorporates 5-watt amplifier with frequency response



of 60–12,000 cycles. 8-inch woofer and 3-inch tweeter with crossover network. — **Audio-Master Corp.,** 17 E. 45 St., New York, N. Y.

HI-FI RECORD CHANGER, *GS-77.* Automatic and manual operation at 4 speeds. Intermixes and plays all sizes of records at any selected speed,

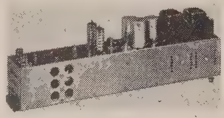


and automatically intermixes and plays 33- and 45-rpm records without regard to sequence. 5-second change cycle. 4-pole hum-shielded motor.—**Glaser-Steers Corp.,** 2 Main St., Belleville, N. J.

AUDIO EQUIPMENT, transisorized *TM series. TM-4* (illustrated) and TM-2, remote and studio mixer amplifiers. Fre-

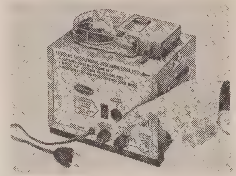
quency response: ±1 db, 60–17,000 cycles. Gain: 20 db, 30-db optional. 50–600-ohm input, 50- and 600-ohm outputs. Temperature-stabilized circuitry.—**Dunlap Electronics Inc.,** 764 Ninth St., Des Moines, Iowa.

FINAL AMPLIFIER, *H.C.A. single channel.* For large hotel or apartment distribution systems. 6-mc bandwidth. 5-volt maximum output. Built-in power supply. Covers channels 2–13. Maximum gain, 20 db. Input



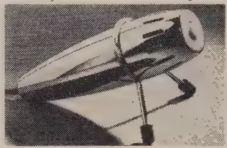
and output impedances, 75 ohms.—**Benco Television Associates Ltd.,** 27 Taber Rd., Rexdale, Ontario, Canada.

TAPE RECORDER, magazine repeater. Pentron *model A-4.* Recorder–playback unit for con-



tinuous or intermittent sales messages or personalized announcements of 1–55 minutes in length.—**Morhan Exporting Co.,** 458 Broadway, New York 13, N. Y.

TAPE-RECORDER MICROPHONE, *model TRC.* Dynamic

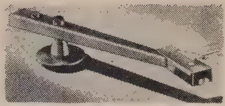


and ceramic types. Push-to-talk control with locking position. 4¾ inches long, 1¼-inch diameter. — **Elgin National Watch Co.,** Elgin, Ill.

MICROPHONES, general-purpose *Commando series. Model 420* lavalier type worn around the neck. *Models 415* and *430* (illustrated). For tape record-

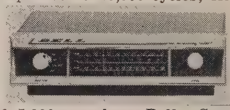
ing, PA systems, etc.—**Shure Brothers Inc.,** 246 Hartrey Ave., Evanston, Ill.

TONE ARM, high-fidelity Micro-Balanced with two sealed viscous-damped pivots for horizontal and vertical movement. Stylus force adjustable from 0 to 15 grams. Single-hole



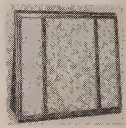
mounting.—**Gray Manufacturing Co.,** Arbor St., Hartford, Conn.

FM–AM TUNER, *model 2520.* FM tuning with or without afc. Sensitivity: 20 μv for 20 db of quieting. Logging scale. Inputs: 72 and 300 ohms. FM frequency response: 20–20,000 cycles; AM:



20–5,000 cycles.—**Bell Sound Systems Inc.,** 555 Marion Rd., Columbus 7, Ohio.

SPEAKER SYSTEM, *SFB/3.* Ready-to-play 3-way system. 12-, 10- and 3-inch speakers. Two styles: *Warwick* (illustrated) and *Windsor.* Walnut, mahogany or blond finish.—**British**

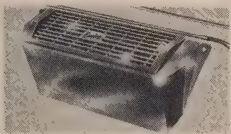


Industries Corp., 80 Shore Rd., Port Washington, N. Y.

CERAMIC CARTRIDGES, *5 series,* Two models: *5T* (illustrated) turnover cartridge for 78- and 45–33-rpm records; and

5P single-needle model for either 78- or 45–33-rpm speeds. Both have sapphire needles.—**Sonotone Corp.,** Saw Mill River Rd., P. O. Box 200, Elmsford, N. Y.

REAR-SEAT SPEAKER, *Car-Fi II,* for convertibles and sport cars. 2½ x 10-inch speaker. Silicone-treated cone. Mounts

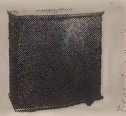


on back of front seat. Molded plastic case.—**Empire Electronics Inc.,** 22022 Woodward Ave., Ferndale 20, Mich.

SPEAKER, *model 217.* Same specifications as previous speakers produced by this manufacturer but using a chemically

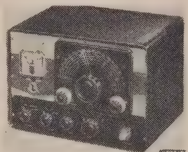
treated cone (polymerized). Clearer, flatter response with absence of resonance is obtained.—**Hartley Products Co.,** 521 E. 162 St., New York 51, N. Y.

SPEAKER SYSTEM, *Monte Carlo.* Includes six moving coil speakers, two 12-inch and four 3-inch units. 4-ohm impedance. Handles 30 watts continuously



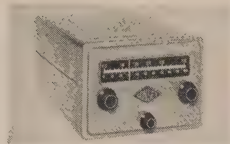
and 60-watt peaks. Frequency range: 25 – 20,000 cycles.—**Weathers Industries,** 66 E. Gloucester Pike, Barrington, N. J.

TRANSMITTER-EXCITER, *Viking Navigator.* 40 watts CW. Pi-network output matches 40–600-ohm transmission line impedance. Bandswitching from 160 through 10 meters. Internal vfo



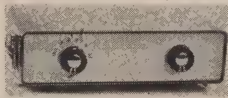
or crystal control. Kit or wired. —**E. F. Johnson Co.,** Waseca, Minn.

VHF RECEIVERS. Each model has 8 tubes plus rectifier. Power supply for 115-volt ac operation and loudspeaker are built-in. Tunable units available in



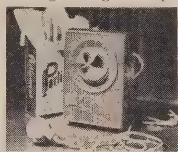
ranges: 30–50-mc FM, 112–132-mc AM, 132–154-mc AM and 154–174-mc FM. Crystal controlled fixed-frequency models also manufactured. — **Gonset, Div. of L. A. Young Spring & Wire Corp.,** 801 S. Main St., Burbank, Calif.

BROADCAST TUNER, *model R*



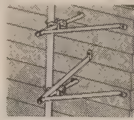
909 B.C. Designed to work with marine radiotelephone units. Provide broadcast entertainment while still maintaining monitor service on marine frequencies.—**Kaar Engineering Corp.,** 2995 Middlefield Rd., Palo Alto, Calif.

TRANSISTOR RADIO, *XR-2.* Reflex circuit with diode detector. Operates on 3 penlight cells. Lightweight earpiece.—



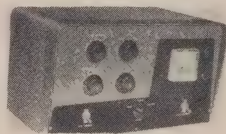
I. D. E. A., Regency Div., 7900 Pendleton Pike, Indianapolis, Ind.

ANTENNA MOUNTS, 15 new models. 2 adjustable wall mounts (illustrated), universal swivel-base mount, ground mount, swivel roof mount and

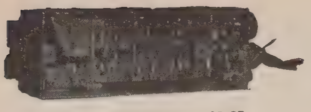


3 adjustable eave mounts, 2 wall mounts, snap-in wall mount and 4 tubular wall mounts.—**Channel Master Corp.,** Ellenville, N. Y.

ANTENNA TUNER, *Globe Matcher Jr., model AT-3.* For transmitters with power input of 100 watts or less. Provides second - harmonic attenuation. Unbalanced output. *Globe Match-*



er, Sr., model AT-4. Handles up to 600 watts rf input. Has built-in VSWR bridge. Class-B and -C linear amplifier, *model LA-1.* Maximum plate power input 200 watts when operated AM class-B linear, 300 watts dc input or 420 P-E-P input as class-B linear SSB or DSB. Requires 15 watts



Receiver R-1/ARR-1—$1.95

A two-stage RF superhet converter in range of 234-258 Mc. Ideal for conversion to various preselectors, ham 220 Mc. converter, or other uses. Uses 4—954 acorn tubes supplied. In compact aluminum case 10" x 3½" x 3". Filaments operate from 12 or 24 V. by merely throwing switch contained in unit. Complete with conversion article as in Jan. 1949 "Radio-TV News." Brand new demilitarized units (input coil insulation broken—easily repaired). Ship wt. 4 lbs. Price **$1.95** ea.
12 or 24 V. co-axial antenna relay for above or other mobile transmitter-receiver equip. New..........**$1.25** ea.

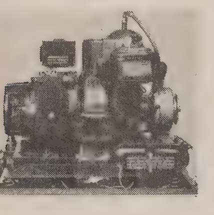
"HUNTERS & SPORTS HEATERS"

Kerosene or Gasoline Heater

Reduced to $4.95

Brand new. Evans blue flame heater. Output approx. 50,000 BTU. Ideal for garage or shack where not confined. Size: 10" dia. x 12" high. Cost Govnmt. many times our low price. Shipped in orig. packing; wt. 47 lbs..........$4.95

HRU-28A GENERATOR—$79.50



Homelite gasoline generator 28.5 V. DC at 2 KW. 3400 RPM motor speed. Electric or rope start. Use to power surplus aircraft radio equipment, cabin or marine power, aircraft starting, etc. These units rebuilt like new by the U.S. Air Force and have not been run since. Size 21½" x 24⅝" x 17½". Wt. 115 lbs. Original AF boxed. Guaranteed. Ship. wt. 210 lbs. "Instruction book included."

BRAND NEW DYNAMOTORS

Type	Input Volts DC	Output Volts	Out-put A.	Ship. Wt. lbs.	Price
DM-42	12 V.	515 and 1030	.260	30	$12.95
DM 40	12 V.	172	.138	7½	2.75
PE-94B	28 V.	150-300	.260	50	3.95
DM-34	12 V.	220	.080	7	used 1.95
DM-36	24 V.	220	.080	7	2.75
DM-45A	24 V.	250	.050	5	2.25
D-101	27 V.	285	.060	5	2.25

Inverters:
Type 12119-1B Remote Compass 12 V. DC input 24 V. 400 cy. output. Ship. wt. 5 lbs. New..........$4.95 ea.
Class A 24 V. DC input—125 V. 400 cycle 100 VA. Single phase 1.0 PF output. Size 6" x 4½" x 8½". Ship. wt. 14 lbs. New..........$7.50 ea.

GOLF CAR MOTOR—$4.50

New 1¾ HP. battery operated motor for building up your golf car or other use. Operates from 12 to 24 V. with speed to 6000 RPM. Measures 4⅛" dia. x 9" long. ⅝" shaft. Wt. 11½ lbs. Ship. wt. 13 lbs.

954 ACORN TUBES—5¢ ea.

Cartons of 200 brand new, individually boxed surplus RCA 954 acorn tubes. With a list price of over $800. Yours for $10 carton. (No broken cartons sold.)

TS-9 HANDSET—$1.99

PARTS KITS: $2.99 ea.

Many of these kits may be purchased for less than any single item alone. Convenience of having parts at hand saves you time and money. All new useful parts. No dogs. All popular brand mdse. Your word-of-mouth advertising makes our business. Satisfaction Guaranteed or money refunded.

C. KIT MIDGET VARIABLES
Includes 10 assd. variables such as 100 mmfd. BUD MC1265 31 plate (reg. net $2.45), 243 mmfd. dual 33 mmfd. also 3, 15, 35, 50 and 100 mmfd. All midline types. Ship. wt. 3 lbs.

D. KIT PAPER TUBULAR CONDENSERS
50 popular sizes including plastic and metal encased from .001 mfd. to 1 mfd. 600 V. and cathode by pass types. Popular brands, no freak types or sizes. Ship. wt. 3 lbs.

E. KIT TUBE SOCKETS
829, 832, Steatite, XU-4 Pin, Acorn, miniature, octal, loctal, wafer, and molded types. A whale of a buy. 50 in all. Ship. wt. 3 lbs.

F. KIT RADIO KNOBS 100
100 various knobs for radio & television. Push on, set screw, pointer, audio, red, brown, black and white. All for reg. ¼" shaft. Ship. wt. 3 lbs.

G. KIT WAFER SWITCHES
25 assorted bakelite and steatite insulated single & multi-gang types for band change and other circuits. Ship. wt. 4 lbs.

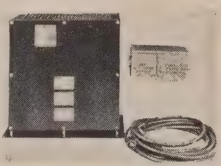
H. KIT RHEOSTATS & POTENTIOMETERS
25 assorted replacement, regular & midget types. Ship. wt. 4 lbs.

I. KIT MOUNTING HARDWARE
100 pcs. various terminal strips of screw & solder types. Ship. wt. 3 lbs.

J. KIT COILS
50 pcs. Contains RCA TV IF's, Osc. HV. osc. RF choke, antenna, & RF coils. Ship. wt. 3 lbs.

K. KIT INSULATORS
50 pcs. Includes aircraft strain, antenna, feed thru, stand off, and mounting types. All low loss. Ship. wt. 6 lbs.

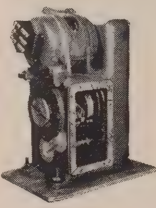
30 AMP. BATTERY CHARGER WHILE SUPPLY LASTS—$12.50 ea.



Cost Government $300 ea. Our purchase of large quantity allows this bargain. Ward-Leonard Mfgd. Type ED 33510. Charging rates up to 30 amps. on 12-30 volt battery combinations (6-15 cells). Operates from 110 V. C. Size 20" wide x 20" high x 10" deep. Shipped in original overseas pack with spares and cord. Wt. 65 lbs. Ship. wt. 145 lbs.

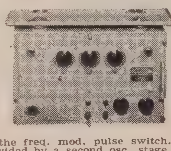
New Torque Amplifier Only $9.75

FOR USE WITH SYNCHROS SIZE 5, 6, 7



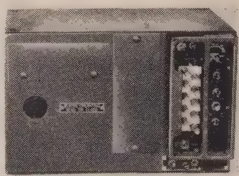
Provide torque amplification and ease in rotation of input shaft. Rotating power applied to input shaft is reproduced in any direction on the output shaft. Torque supplied entirely by a 1/40 HP 110 V AC motor through gear and planetary drive hookup. Speed varies directly with rotation of input shaft with noticeable loss of accuracy. Motor requires capacitor of 85-120 mfd. for starting. Designed for use on gun control devices and cost the Govnmt. hundreds of dollars to mfg. In cast aluminum case. Size: 12" h. x 5⅜" w. x 7½" d. Wgt. 23 lbs.
Packed in original wood box. Shpg. wt. 45 lbs.
Brand New..........**$9.95**
Starting capacitor for above Torque Amplifier. New....**$1.00**

OAV-1 TEST SIGNAL GENERATOR, $12.50 ea.



This signal generator was used to provide a test signal of constant frequency for operation and alignment of IF and amplifier stages in the CG-46 ACQ type receivers. The generator covers the range between 150-250 megacycles. Amplitude modulated square wave output is obtained at frequencies of .1, 1, 10 and 100 kc. depending on the position of the freq. mod. pulse switch. A 15 Mc. signal is also provided by a second osc. stage. Power is supplied by internal 115 V. 60 cycle AC supply connected to source by cord provided. Brand new with instruction book. Ship. wt. 62 lbs..........**$12.50** ea.

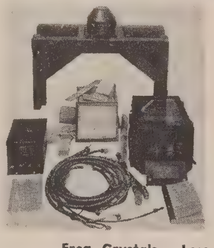
BC-604 Transmitter—$9.95 ea.



30 watt crystal controlled on 10 preselected channels in range of 20-27.9 Mc. F3 emission. Operates from 12 V. or 24 V. DC (dynamotor not supplied). Tubes and meter supplied worth the price of entire unit. Size 18" x 10" x 12". Excellent to new condition. Ship. wt. approx. 100 lbs. ea. Price **$9.95 each.**
Receiver and Transmitter combination..........**$25.00** set
Order a receiver and transmitter combination for mobile or fixed station or for wireless intercom.

Metal Locators—$39.50

The famous SCR-625 mine detector which has been found to be unexcelled for locating hidden metallic objects such as pipes, treasure, etc. Hundreds in use by prospectors, mining companies, plumbers, veneer mills, etc. Comes complete in carrying case and checked ready for operation with addition of batteries below. Case size 28¼" x 16" x 8¼". Operating carrying wt. approx. 15 lbs. Ship. wt. 55 lbs. Price **$39.50** ea.
Batteries for above SCR-625 $4.25 set.



M-1 Odograph, over $5,000 value—$89.50

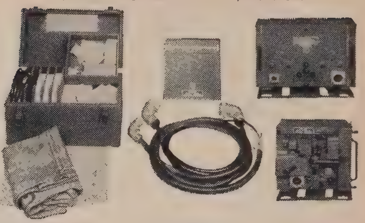
See Nov. 1944 Electronics for Full Description

This is a survey instrument for automatically drawing a map of the terrain over which the jeep or other vehicle to which it is attached traverses. These instruments mfgd. currently by Monroe Calculating Machine Co. and sold in excess of $5,000. Our surplus purchase allows passing on these machines at this value. Order early, only 200 in stock. Units have been rebuilt by Corp of Engineers, U.S. Army and guaranteed good condition. Ideal for prospectors, oil companies, power line and farm use. Nothing else needed for operation except vehicle. Many are using the compass unit for automatic pilots on boats—many, many applications. A real machine. Ship. wt. approx. 300 lbs..........Our Price **$89.50** ea.

Freq. Crystals...Less Than 5¢ Ea.

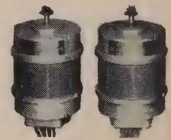
Imagine crystals costing Govnmt. $3.50 to $12.50 ea. in this assortment. 100 brand new; various freqs.; plenty in ham bands. Practically all types of holders; all mounted; guaranteed to oscillate.
Assortment of 100. Ship. wt. 4 lbs..........**$4.95**

RC-58-B FACSIMILE SET—$59.50 ea.



Brand new, complete, ready to operate by connecting to 12 V. DC source. Spare parts included with ample supply of ink and paper. Transmits and receives and prints, signatures and copy. Ideal for loan offices, banks or other businesses where signatures must be verified, etc. Use two sets together with 2 wires telephone line or radio carrier between. Cost Gvmt. approx. $6000. Your price, in original packing, only **$59.50** ea. Ship. wt. approx 300 lbs.

SYNCHROS, SELSYNS, AUTOSYNS!!!
At money-saving prices!!!
LARGE QUANTITY
20,000 in stock
110 v. 60 cycle Units



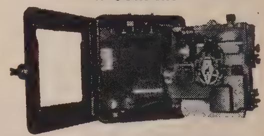
Navy Size & Type	Approx. Weight (lbs.)	Approx. Length (Inches)	Approx. Diameter (Inches)	Price Used
5F	5	6.0-6.8	3.4-3.6	$5.00
5G	5	6.0-6.8	3.4-3.6	5.00
5DG	5	6.0-6.8	3.4-3.6	5.00
5CT	5	6.0-6.8	3.4-3.6	5.00
6G	8	6.4-7.5	4.5	7.50
7G	18	8.9-9.2	5.8	10.00
7DG	18	8.9-9.2	5.8	10.00

110 V. 400 Cycle Units

Size & Type	Approx. Weight (lbs.)	Approx. Length (Inches)	Approx. Diameter (Inches)	Price Used
5F	5	6.0-6.8	3.4-3.6	$3.50
5G	5	6.0-6.8	3.4-3.6	3.50
5DG	5	6.0-6.8	3.4-3.6	3.50

CT—Control Transformer: D—Differential Motor:
DG—Differential Generator: F—Motor (Follower):
G—Generator. Mfg. by Bendix, Ford Instrument Co. and General Electric. Specify. Bendix, Ford & GE in stock

LEEDS & NORTHRUP MICROMAX RECORDERS



Strip type recorder used for controlling and recording wide variety of processes. Used originally for temp. range of 350-550° C. but may be changed for other applications. Operates on Wheatstone bridge principle using AC galvanometer movement. Original cost several times our low price. Removed from demilitarized equipment which in many cases was new. Sold as used but guaranteed, or money back if not satisfied. Ship. wt. approx. 165 lbs. **$179.50** ea.

D-2 Auxiliary Power Plant Engines

Fairchild 10 h.p. at 3200 r.p.m., magneto shielded ignition, two cylinder, air-cooled type. Made to drive P-1, R-2 and NEA-3 type generators. Automatic altitude control for use to 40,000 feet. Use this engine to drive generators for welders or other uses where light weight quality engine is required.
Guaranteed like new condition. Shipping weight 125 lbs. each.

Price $85 each

24v. 200 amp. generator for above

$19.50 each.

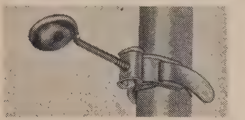
Shipping weight 50 lbs. each.

ESSE RADIO CO. 42 WEST SOUTH ST. INDIANAPOLIS 25, IND.

REMIT SHIPPING CHARGE AND INSTRUCTIONS WITH ALL ORDERS. OTHERWISE ORDER WILL BE SHIPPED EXPRESS COLLECT. ALL ITEMS GUARANTEED TO YOUR SATISFACTION OR MONEY REFUNDED IF RETURNED PREPAID WITHIN 10 DAYS OF RECEIPT

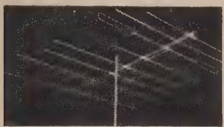
rf driving power. Up to 200 watts class-C CW with 18 watts drive. All units available kit or wired.—**WRL Electronics**, 34th & Broadway, Council Bluffs, Iowa.

UNIVERSAL STRAP STAND-OFF, *IMP*. Accommodates Nos. 8 and 9 standard wood-screw



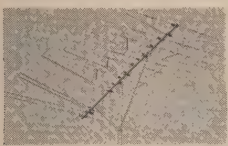
eyes. Zinc-coated steel buckle with galvanized or stainless-steel strap.—**JFD Manufacturing Co.**, 6101 16th Ave., Brooklyn 4, N. Y.

TELEVISION ANTENNA, *Golden Topliner*. Anodized gold-color elements. 4 models. Single



or stacked arrays, depending on required gain. *G2540, G2550, G2560* and *G2570*.—**Technical Appliance Corp.**, Sherburne, N. Y.

TRIO COLOR ROYAL, an all-channel color TV antenna. High forward gain and high signal-



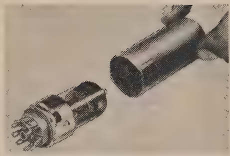
to-noise ratio. Flat frequency response over the vhf band.—**Trio Manufacturing Co.**, Griggsville, Ill.

ALL-TRANSISTOR AMPLIFIER. 20 watts. For PA sys-

tems. Plugs in .50-20,000 cycles. Includes peak clipping and gain control.—**Universal Transistor Products Corp.**, 143 E. 49 St., New York 17, N. Y.

CABINET RACKS, heavy duty. Removable rear door. Panel mounting rails integral part of sides. Accommodates standard 19-inch panels.—**Bud Radio Inc.**, 2118 E. 55 St., Cleveland 3, Ohio.

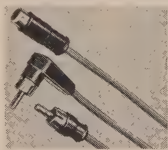
MAGNETIC SHIELDS. Fit 7- and 9-pin vacuum-tube socket assemblies with bayonet type flange. Shielding material insensitive to shock and may be worked or transported without affecting its magnetic shielding qualities. Does not retain residual magnetism or require pe-



riodic annealing.—**Perfection Mica Co.**, Magnetic Shield Div., 1322 N. Elston Ave., Chicago 22, Ill.

CONNECTORS, *Q Quick-Disconnect* series. 3 sizes with 3 shells: *QO2*, square flange receptacle; *QH25*, hermetically sealed round-flange receptacle and *QO6*, straight plug.—**Cannon Electric Co.**, P. O. Box 3765, Terminal Annex, Los Angeles 54, Calif.

PHONO PLUGS AND JACKS molded to extension cable. Straight and right-angle types. Shielded handle. — **Switchcraft**

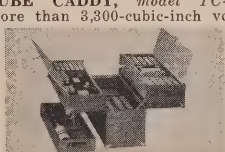


Inc., 1328 N. Halsted St., Chicago 22, Ill.

FILM-COATED WIRE, *Beldsol*. Solders without stripping. Coated with Polyurethane film. AIEE Class-A 105°C. For transformers, motor armatures, field coils, radio and TV universal coils, etc.—**Belden Manufacturing Co.**, 4647 Van Buren St., Chicago 80, Ill.

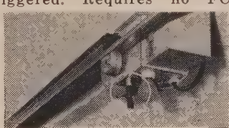
PRINTED-CIRCUIT BASE, *Fluorply-F Laminate*. High bond strength of copper foil to plastic base. High dielectric strength. Readily cold-punched, drilled or machined. — **International Resistance Co.**, 401 N. Broad St., Philadelphia 8, Pa.

TUBE CADDY, *model TC-5*. More than 3,300-cubic-inch vol-



ume. Removable tool tray. 24 x 16½ x 8½ inches.—**Argos Products Co.**, Genoa, Ill.

GARAGE-DOOR OPENER, remote-controlled **Genie Lift-A-Dor**. Cannot be accidentally triggered. Requires no FCC



license. Unlocks, opens, lights, closes and locks overhead garage doors. Limited-range low-frequency principle.—**Alliance Manufacturing Co. Inc.**, Lake Park Blvd., Alliance, Ohio. END

All specifications given on these pages are from manufacturers' data.

Technicians' News

ANNUAL CONVENTION

The National Alliance of Television & Electronic Service Associations (NATESA) held a 4-day convention in Chicago, Ill., whose attendance exceeded last year's high of 712.

During the session, a constitutional amendment, eliminating the last possible hindrance to the affiliation of existing state associations with NATESA, was placed in the record to be voted on at the spring directors' meeting. This meeting was voted to Missouri after invitation by a number of NATESA affiliates in that area. Buffalo, N. Y., and Miami, Fla., also extended invitations.

New officers were elected, with Russell Harmon of Cincinnati, Ohio, selected to succeed Robert Hester as president. Hester could not succeed himself. Mac Metoyer, Kansas City, was voted secretary while Nelson Burns, Memphis, Tenn., was renamed treasurer. Bertram Lewis, Rochester, N. Y.; Cordell Britt, Nashville, Tenn.; Vincent Lutz, St. Louis, Mo.; and Winston Haines, San Mateo, Calif., were elected as vice presidents in their respective divisions. The following were elected secretary for their division: Pat Pratt, Buffalo, N. Y.; Marvin Miller, Springfield, Ohio; Joe Driscol, St. Paul, Minn.; A. Andrew, Denver.

ESFETA MEETS

Licensing was the major issue discussed at the regular September meeting of the Empire State Federation of Electronic Technicians Associations, Inc. (ESFETA), held in Ithaca, N. Y. Ben DeYoung acted as the host.

Dan Hurley, ESFETA president, pointed out that there was a possibility that captive service would benefit from a governmental licensing program. This would be due to the possibility of 30% of the practising technicians being eliminated, leaving an expanded market for the manufacturer.

Robert Henderson, Long Island delegate, stated that the self-licensing program in their area hasn't brought any noticeable response from the public. George Carlson, secretary, reported that Jamestown's self-certification program has resulted in public response, but only when individual members advertise their membership and the association presents the program through local advertising.

Bert Lewis, eastern vice president of NATESA, representing Rochester, urged ESFETA to encourage its members to participate in the CBS transistor training program.

The next meeting will be held Nov. 10 in Rochester. Norbert LeMay will act as host.

SERVICE SEMINAR

Fifty representatives of independent service organizations had a 2-day seminar at Lancaster, Pa. in the early part of September. Conducted for discussion of the latest improvements and developments in service techniques, and sponsored by RCA, a tour of the color picture-tube facilities at RCA's Lancaster plant and a preview of the fall color TV receiver sales program was included. The Quality Control Laboratory at Browns Mill, N. J., and the David Sarnoff Research Center, Princeton, N. J., were visited during the closing day of the session.

Addressing the group, D. R. Creato, secretary and vice-president of the RCA Service Co., noted that electronics has become an $11.5-billion-a-year industry and that servicing represents $2.8 billion or, roughly, a quarter of this total.

APPRENTICESHIP GUIDE

The Minnesota Television Service Engineers, Inc. (MINTSE) and Tung-Sol Electric Inc. have jointly published a Radio-TV Apprenticeship Standards Guide. The booklet, called *Service Standards,* contains a complete description of MINTSE's apprenticeship program.

According to John W. Hemak, who compiled the manual, its purpose is "to establish a foundation for the eventual recognition of electronic service as a professional activity."

The guide was printed by Tung-Sol through the efforts of Robert M. Andrews, manager of electronics and semiconductor products advertising. Copies are free to all jobbers, dealers and associations. They may be obtained from local Tung-Sol jobbers or by writing: TTLB, Special Services Dept., P. O. Box 1321, Indianapolis, Ind.

NEW SERVICING IDEA

A new group called Telectro Service Associates, Inc., has been formed in Detroit, Mich. A profit-making organization, it was formed by independent service dealers to promote and contract service for the service dealer.

Telectro has signed contracts with Philco and Sylvania to handle their warranty service on television, radios and phonographs. Local Hotpoint distributors have also selected Telectro to perform this job for them. Independent local service dealers will handle work in their area.

Officers of Telectro are: Karl Heinzman, H. & M. Electric, president; John Keppinger, Grosse Pointe Radio, vice president; Philip Fabian, Dexter TV, secretary, and Edward Brown, Visual Electronics, treasurer.

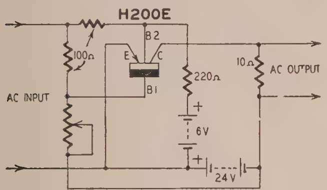
Board members are: E. J. Barton, Barton TV, 2 years; Steve Raboczkay, Southwest TV, 2 years, and Edward Corrozzi, Supreme TV, 1 year. END

New Tubes & Semiconductors

The manufacturers have presented a versatile group of vacuum tubes and semiconductor devices this month. There's the world's first power tetrode transistor; a photocell that needs no amplifier circuit; a miniature power-output tube; a 110° picture tube and a rectangular 3-inch C-R tube. And to round out the collection you'll find an 85-watt power transistor.

H200E

A germanium p-n-p alloyed-junction power-tetrode transistor and designed to operate from 28-volt collector supplies, its linear amplification over wide current ranges permits high power output with low distortion. It is made by Minneapolis-Honeywell. A power



output stage to demonstrate its excellent linearity is shown in the diagram. A low-distortion high-efficiency high power output is achieved without feedback and without input transformer drive. Hence, the circuit may be R-C-coupled or direct-coupled to a preceding stage. Up to 5 watts output can be obtained.

2N332, 3, 4, 5, 6

These grown-junction silicon transistors are especially designed for high-gain low-level applications where maximum reliability at a high ambient temperature is of prime importance. Made by Texas Instruments, the maxi-

2N332,3,4,5,6

mum temperature range of these units is −55° C to 175° C. Input impedance (h_{ib}) for all five units has a design center of 42 ohms, when C_{CB} = 5V and I_E = −1 ma; and the noise figure (NF) has a design center of 20 in the common-emitter configuration compared to a 1,000-ohm resistor.

The following maximum ratings (at 25° C) apply to all five units:

V_{CB}	45
V_{EB}	1
I_C (ma)	25

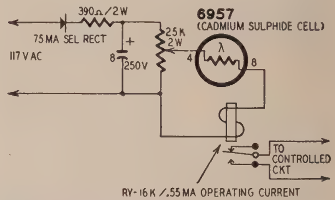
I_E (ma)	−25
P_C (mw)	150
at 100° C	100
at 150° C	50

Center design ratings:

	2N332	33	34	35	36
Power gain (PG_E) ($V_{CE} = 20$, $I_E = -2$ ma) ($R_g = 1$ k, $R_L = 20$ k)	35	39	39	42	42.5
Frequency cutoff (mc) ($V_{CB} = 5$, $I_E = -1$ ma)	4	5	8	6	7

6957

Head-on type of cadmium-sulfide photoconductive cell for use in light-operated controls. High illumination sensitivity permits direct relay operation in most applications without an amplifier. The unit is made by RCA.



Maximum ratings are: polarizing voltage, 250; power dissipation, sensitive surface fully illuminated, 0.5 watt; photocurrent 50 ma.

The diagram shows a typical high-sensitivity circuit using the 6957. The cell connects to pins 4 and 8 of an octal base.

Abbreviations

A number of abbreviations used in reference to transistor characteristics are often confusing. To end any doubt as to what a particular symbol stands for this list has been assembled.

I_C, I_E, I_B—Dc currents to collector, emitter or base.

V_{CB}—Voltage, collector to base.

V_{EB}—Voltage, emitter to base.

V_{CE}—Voltage, collector to emitter.

V_{BE}—Voltage, base to emitter.

BV_{CBO}—Breakdown voltage, collector-to-base junction reverse-biased, emitter open-circuited (value of I_C should be specified).

V_{CEO}—Voltage, collector to emitter, at zero base current with the collector junction reverse-biased. Specify I_C.

BV_{CEO}—Breakdown voltage, collector to emitter, with base open-circuited.

V_{CCB} — Supply voltage, collector to base.

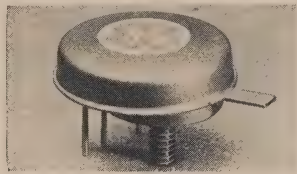
C_{CCE} — Supply voltage, collector to emitter.

V_{BBE}—Supply voltage, base to emitter.

Watch for more of this list next month.

2N451

This 65-volt 85-watt silicon power transistor, is designed to be used in dc–dc or dc–ac converters as well as servo amplifiers, engine controls and power supplies. Capable of dissipating



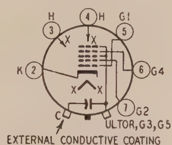
85 watts at 25° C, the G-E 2N451 has a nominal collector saturation resistance of 2 ohms.

Input impedance at a collector current of 1 amp is 25 ohms at 25° C. Maximum collector current rating is 5 amperes. Beta cutoff is 400 kc.

Produced by a vapor-diffusion process, the 2N451 is hermetically sealed in an all-welded case designed for mounting on an external heat sink by means of a single threaded stud.

21CQP4

A 21-inch rectangular glass type television tube, it uses 110° magnetic deflection and electrostatic focusing. Announced by Sylvania, the 21CQP4 utilizes a straight electron-gun design,



21CQP4

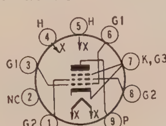
eliminating the need for an ion trap. It has a 6.3-volt 600-ma heater with a controlled warmup time of 11 seconds.

Maximum ratings are:

Ultor voltage		19,800
V_{g4}	(pos value)	1,100
	(neg value)	550
V_{g2}		550
V_{g1}	(neg bias value)	154
	(neg peak value)	220
	(pos bias value)	0
	(neg bias value)	2
	Peak, heater–cathode voltage	200
	(during warmup) (15 sec)	450

6973

A high-perveance beam-power tube of the nine-pin miniature type, designed for use as a power amplifier in high-fidelity audio equipment. Announced by RCA, it has a 6.3-volt 450-ma heater.



6973

Typical operating values when used in a push-pull af power-amplifier circuit, pentode-connected with fixed bias, are:

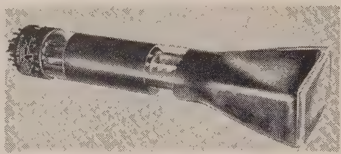
Values are for 2 tubes

V_P	250	350	400
V_{g2}	250	280	290
V_{g1}	−15	−22	−25
Peak af g1 to g1 voltage	30	44	50

I_P (0 sig) (ma)	92	58	50
(max sig)	105	106	107
I_{g2} (0 sig) (ma)	7	3.5	2.5
(max sig)	16	14	13.7
R_P (plate to plate) (k ohms)	8	7.5	8
Total harmonic distortion (%)	2	1.5	2
Max sig pwr output (watts)	12.5	20	24

3AHP1, 2, 7, 11

This rectangular cathode-ray tube uses electrostatic focusing and deflection. It is 9.12 inches long, has a 6.3-volt 0.6-amp heater and is produced by Waterman Products Co.



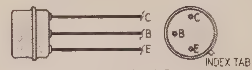
Typical operating conditions are:

V_{A2}	2,000
V_{A1}	330–620
V_{g1}	158 to 135
Deflection factors	
D1 and D2	146–198
D3 and D4	52–70

Basing diagram same as for 3RP1.

4JD4A4, 5

These silicon triode transistors are intended for amplifier applications in af and rf ranges. Both are diffused-junction devices manufactured by General Electric by a diffused-meltback process. They have a nominal input



4JD4A4,5

impedance (h_{ib}) of 55 ohms, when $I_E = -1$ ma and $V_{CB} = 5$. Nominal current-transfer ratio is 15 for the 4JD4A4 and 40 for the 4JD4A5, when $I_E = -2$ ma and $V_{CB} = 5$.

Maximum ratings at 25° C are:

V_{CBO}	30
V_{CEO}	15
V_{EBO}	5
I_C (ma)	30
P_C (mw) (25° C)	150
(150° C)	25
Nominal frequency cut-off (mc) (f_{ab}) $I_E = -2$ma $V_{CB} = 5$	25

RCA pix tubes

Three 90° television picture tubes have been announced by RCA. All have a straight gun design and do not need an ion-trap magnet. They are the 21CBP4-A, 24AEP4 and 17BJP4.

6DQ5 Correction

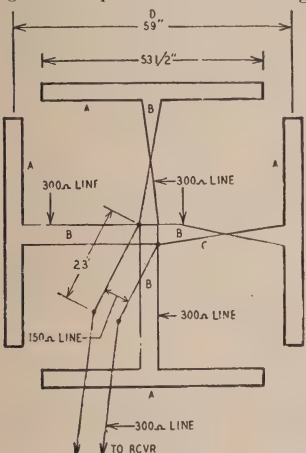
An errata notice from RCA has indicated a change in the information presented in their original specifications for the 6DQ5, which appeared in the September issue on page 138. The connections for grid 1 and grid 2 were reversed. The correct connections should be: Pin 1 connects to grid 1 and pin 4 connects to grid 2. END

radio-electronic Circuits

FM ANTENNA

Recently I constructed an omnidirectional FM receiving antenna from details in the article "All-Way FM Antenna" in the March 1948 issue of RADIO-CRAFT. The antenna worked so well that I'd like to recommend it to those who haven't seen it.

The dimensions on the diagram are for the FM broadcast band. The dipoles (A) are made of 300-ohm ribbon and are 0.45 wavelength long. The square is 0.5 wavelength



long on each side. The four antennas in parallel have an effective impedance of 75 ohms when connected as shown by 0.25-wavelength phasing sections (B). The 75-ohm feed-point impedance is matched to the 300-ohm transmission line (lead-in) by a 0.25-wavelength section of 150-ohm line (C).

For other frequencies the dimensions of A, B, C and D in inches may be found by dividing 5,350, 2,950, 2,300 and 5,900, respectively, by the frequency in megacycles.—*Henry O. Maxwell*

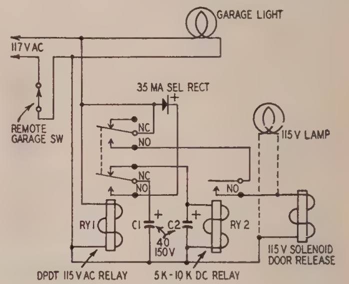
LIGHT SWITCH CONTROLS GARAGE-DOOR OPERATOR

I wanted to install an electrically controlled solenoid release for a spring-operated garage-door opener in a home with a garage light controlled from a remote switch in the house. To avoid putting in special wiring and switches, I worked out a scheme for controlling the door operator and garage light individually from the original light switch. The circuit shown is designed so normal operation of the light switch will not activate the door opener but

the opener can be operated instantly from the same switch. Moreover, it is impossible for current to flow through the solenoid for a period longer than that required to open the door. This prevents an excessive duty cycle and keeps the opener coil from oveheating.

The circuit connects to the ac line supplying the garage light. The connection can be made through an extension cord run from an adapter in the light socket. With this unit, the opener is operated by switching the light on, then off and then on again within a few seconds. The second time that the light is switched on, the opener solenoid receives a 117-volt ac pulse of sufficient length to open the door, but not longer, even though the light remains on. Successive operations of the switch will not operate the solenoid if the on–off interval is longer than several seconds.

Here's how it operates: When the dpdt 115-volt ac relay (RY1) closes (with each closure of the light switch), the lower set of contacts allows C1 to charge from the selenium rectifier. When RY1 is released seconds later by

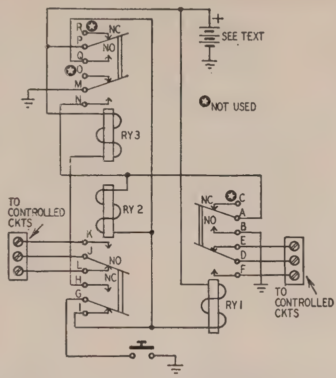


turning off the light, the normally closed contacts connect the charged capacitor (C1) across C2 and the coil of dc relay R2. RY2 now closes and remains closed until most of the charge on C2 has leaked off through its high-resistance coil. (The period that RY2 remains closed is determined by its coil resistance and armature spring tension and the capacitance of C2.)

The solenoid will not operate if the light switch is kept off until after RY2 opens. But, if the switch is closed before RY2 opens, line voltage is applied to the solenoid through the closed contacts of RY1 and RY2 in series. Line voltage cannot remain on the solenoid for any great length of time because RY2 opens when most of the charge has leaked off C2. The circuit through the solenoid remains open until the control is triggered again by flipping the light switch off and on again. A low-wattage 115-volt pilot lamp may be connected across the solenoid as shown by dashed lines to indicate a malfunction such as sticking contacts on RY2 which will keep the voltage applied to the solenoid.—*Bruce Morrissette*

IMPROVISED IMPULSE RELAY

During experimental or developmental work we may need a ratchet or impulse type relay to open or close



NC = NORMALLY CLOSED CONTACTS; NO = NORMALLY OPEN CONTACTS (COIL NOT ENERGIZED)

a circuit the first time a current is pulsed through its coil and reverse the circuit connection on the next input pulse. These relays are seldom available immediately. The diagram shows how you can substitute three ordinary dpdt relays of the type usually found in the junkbox and on the surplus market. This circuit is cumbersome and should be replaced by the correct relay when available. It is the electromechanical equivalent of a vacuum-tube or transistor flip-flop.

Spdt contacts available for controlling exterior circuits are D–E–F and J–K–L of RY1 and RY2, respectively. Contacts M–O of RY3 can be used to connect and disconnect a circuit from ground.

Upon closing the pushbutton—or similar momentary switch—the coil of RY1 is energized by current flowing through the switch and contacts G–I of RY2. This closes contacts A–B and auxiliary contacts D–F.

When the switch is released, current now flows to ground through A–B and the coils of RY1 and RY2 to the battery. RY1 and RY2 lock in through A–B. Contacts G–H and J–K are closed.

When the switch is closed for the second time, the coil of RY3 is energized through contacts G–H. Circuit P–Q closes and shorts the coil of RY1, opening A–B and D–E. RY2 is locked in momentarily through M–N which closes before A–B opens.

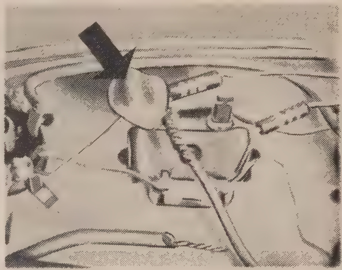
As soon as the switch is released, RY3 opens, breaking contacts P–Q and M–N and removing all excitation and grounds from the coils of RY1, 2 and 3. All auxiliary or control contacts have now been returned to their original positions and the circuit is ready for another cycle.

For proper operation, contacts M–N must be adjusted for a narrower gap than the others so they (M–N) close before A–B opens. The dc resistance or ac impedance—depending on the type of power supply—of the coils of RY1 and RY2 should be equal. The resistance or ac impedance of RY3's coil should be twice the value of the coil in RY1 or RY2. The battery (or ac supply) voltage is determined by relays used. END

try This one

TERMINAL MARKING

If you have ever lost or misplaced a wiring sketch that was drawn as a guide to the replacement of a defective component with many color-coded leads, you will appreciate this convenient method of marking circuit terminals.



Keep a block of multicolored modeling clay on the bench and whenever you unsolder a lead mark the terminal with a small piece of that color clay. Remove the clay as you solder new leads in place.

The clay speeds up the repair and can't possibly become mislaid or lost as a sketch could be.—*John A. Comstock*

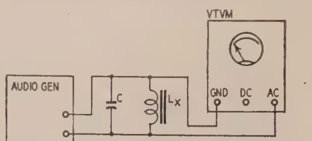
SERVICING AID

When a new set comes into the shop, I always look up the code number for my service manual and jot it down on the back of the chassis with a grease pencil. Whenever one of these sets comes in for repairs I can tell at a glance just what manual contains the reference data. This trick is handy in speeding up future repairs.—*Scot Mock*

INDUCTANCE MEASUREMENT

Very often it is necessary to measure the inductance of unknown or home-made inductors. In most instances test equipment designed for this purpose, such as an impedance bridge, is not available.

The drawing shows a method of determining inductance values with an



audio-frequency generator and a vtvm. The generator is set to provide an R-C-coupled high-impedance output and the vtvm is set to a low ac scale. With

the known capacitor (C) connected in parallel with the unknown inductor (L_x), the generator is tuned through its range until an indication is noted on the vtvm. At this point the tuning should be carefully adjusted and the frequency recorded on a sheet of paper. The value of capacitor C will depend on the tuning range of the generator and the range of inductance to be measured. Capacitor values for use with any frequency range and any range of inductance may be determined by the formula:

$$C = \frac{25{,}330}{f^2 L}$$

where C is in microfarads (μf), L in henrys (h), and f is in cycles per second (cps).

The value of the measured inductance is determined by the formula:

$$L = \frac{25{,}330}{f^2 C}$$

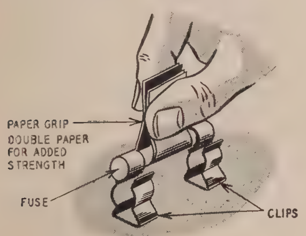
—*Michael S. Robbins*

SHOESTRING AS SPAGHETTI

When I need some insulating spaghetti for low-voltage low-frequency applications, I use a length of shoestring. Since shoestring comes in several different widths and lengths and is hollow, it will fit most conductors. To insulate a wire, I simply select a shoestring of appropriate size, cut it to length, slip it over the wire and spray-insulate it with anti-corona dope. The resulting spaghetti is durable and has good insulating properties.—*J. C. Alexander*

FUSE PULLER

In many TV receivers the high-voltage fuse is located in the high-voltage cage and to technicians with big hands can sometimes prove to be a slippery article.



You can beat this problem by slipping a piece of heavy, brown paper around the fuse for a handle or grip as in the diagram.

Cut a strip just wide enough to fit between the fuse clips — about ¾ x 5 inches. The fuse can be easily pulled or replaced using this paper handle. Keep a couple in your tool kit.—*Frank W. Dresser*

RESISTOR REPAIRS

Vitreous-enameled wire-wound power resistors with cracked or broken ceramic cores can be repaired satisfactorily if the resistance element is unbroken. In a bottle cap, mix a little iron cement (Smooth-On) according to directions.

TRY THIS ONE *(Continued)*

Run a bolt through the resistor with a washer on each end and tighten the nut just enough to hold the broken pieces in place. Apply the iron cement over the break and let it harden before removing the bolt.

This method is better than using a bolt alone to make the repair because it does not interfere with the circulation of cooling air through the resistor. Keep the patch above ground because some of the conductive cement may be touching the wire element.—*D. R. Frank*

TRANSISTOR BATTERIES

Battery packs salvaged from personal type portable radios are handy when experimenting with transistors. The small wafer cells can be reassembled to provide almost any voltage likely to be needed for transistor projects. —*T. Clark*

PREVENT HEAT DAMAGE

Experimenters know that during soldering pliers should be used to absorb the heat on the leads of delicate components. However, it's sometimes

difficult to held the pliers and do the soldering job too. The pliers will hold themselves in place when they are snapped around the lead if a rubber band is stretched around the handles. —*Hugh Lineback*

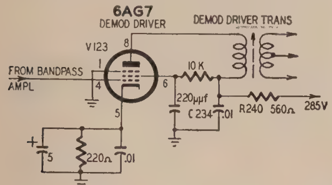
CARBON TET FUMES

In our shop we use a 10-inch electric fan to dissipate the fumes of carbon tetrachloride, contact cleaner and other dangerous chemicals. The fan is kept close to the chassis being serviced so it dissipates the fumes before the technician can detect the odor.—*Seymour Winterfeld* END

"It was so nice of you to invite George and me over for bridge!"

WEAK OR NO COLOR

A fairly common cause of weak or no color in the RCA 21-CT-663U is R240, normally 560 ohms, increasing in value and cutting down grid 2 voltage at V123. Every time this trouble has come up, we have found an inter-



mittent short in the tube or in C234, a .01-µf capacitor. We now change both the tube and capacitor any time R240 has changed value. Apparently the short causes an excessive flow of current through the resistor, heating it enough to change its value.—*Warren Roy*

G-E 805

Complaint, no picture, no sound, no raster, no nothing. This could be anywhere, but most probably low-voltage B or filament supply.

All tubes were lit. With such a group of symptoms there are but few remaining causes for no picture, no sound, no raster.

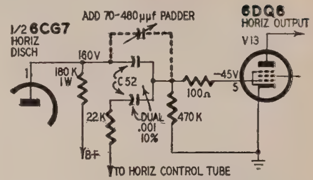
There were no visible signs of any part being overheated, burned or shorted, but I looked carefully for an open. I knew there was ac *coming into* the chassis because the tubes were heated. Tracing the ac line, I found it branching to the filaments and to the rectifier circuit at the line switch. (The switch and a thermal cutout are in series, common to filaments and selenium rectifiers.)

The 5-ohm resistor in the rectifier branch was open. This is a 4-watt, wirewound unit. I replaced it with a 5-ohm *10-watt*, wirewound resistor. Whenever a wirewound resistor in a power supply goes, it is the better part of servicing discretion to replace it with one having twice the wattage rating of the original component.—*David T. Armstrong*

ZENITH Z-2222C

Trouble was narrow picture and decreased brightness. We found that the grid voltage of the horizontal output tube (6DQ6) was 38 volts negative instead of the rated −45.

The set has a fixed input network to the output tube with no means of in-



creasing the drive. A 70–480-$\mu\mu f$ padder was connected across the series half of C52 (2 x .001 μf, 10% dual) as shown in the diagram. The drive was adjusted with the padder and the trouble disappeared.

(The padder could have been connected from the control grid of the horizontal output tube to ground to cure excess drive.)—*L. A. Williams*

WANDERING AGC

This color set, an RCA CTC5N, had a raster but no picture. Tube substitution in the rf, if and Y amplifier had no effect. We noted that normal operation was restored by adjustment of the agc threshold control. We let the receiver run for a while and the picture started to wash out. Replacement of the keyed agc tube did not help. Resetting the threshold control did restore normal operation. We thought of leaky capacitors in the agc line, but before starting on those an audible arc from the high-voltage cage was heard, with the picture overloading.

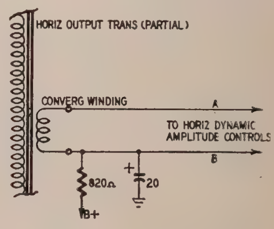
With scope and low-capacitance probe to the plate of the keyed agc tube we were able to see the keying pulse taking a nose dive and then jumping back to more than its initial peak-to-peak voltage. The arc, if still present, was no longer audible.

We replaced the horizontal output transformer as the next logical step. After replacing the transformer the keying pulse remained stable, and the receiver has been operating for a month without further trouble.—*Robert G. Middleton*

MOTOROLA TS902-A

The trouble was loss of horizontal dynamic convergence. No response was obtained by adjusting the horizontal dynamic amplitude controls.

Visual inspection showed that lead A (see diagram) had broken loose from



its joint at the blue amplitude control. The lead was resoldered, but still no response was obtained when the amplitude controls were varied.

A scope check across A and B showed only a 60-cycle parabola, which was being fed through from the vertical

convergence system. Leads A and B were then disconnected and the scope check repeated. Now an apparently normal pulse output was obtained. This was a bit of a puzzler.

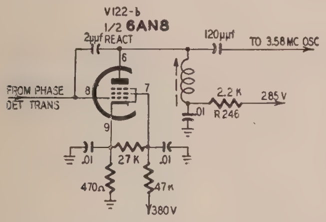
Then an ohmmeter check was made of the convergence winding. Infinite resistance was indicated. The winding was open, but the pulse waveform was observed on the scope screen because the scope has such high input impedance that the capacitive coupling across the open was sufficient to drive it.

When starting to replace the flyback, we observed that the fine wire lead from the convergence winding was melted externally. Another lead was run from the terminal on the flyback board to the coil end, and the system took off and worked normally.

The lead had become fused because B-plus voltage is applied to the convergence winding and the broken lead at the amplitude control had shorted to chassis ground. Fortunately, the winding did not melt inside the coil, so flyback replacement was unnecessary.—*R. M. Centerville*

POOR COLOR SYNC

Last week we had an RCA 21-CT-660U pulled into the shop for poor color sync. With a color program on the air, perfectly normal color saturation

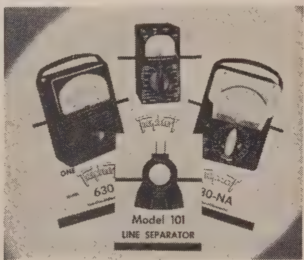


would be present, but the color would just wander. A careful check through the circuit revealed that the V122B, the reactance tube, had low plate voltage. Further checks showed that a 2,200-ohm plate resistor R246 had gone up in value to 3,500 ohms. A quick replacement and everything was back to normal.—*Mark Surgeon* END

"It's our garden rake! I just hooked it up, and it works fine."

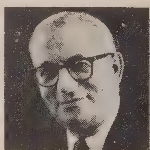
Business and People

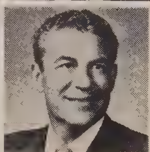
Triplett Electrical Instrument Co., Bluffton, Ohio, in conjunction with its advertising agency, Burton Browne, Chicago, developed a new package for its vom's and vtvm's. Each carton features a life-size photo of the unit for easy identification.



Orradio Industries, Opelika, Ala., is now marking its acetate-base long play tape in a distinctive new box.

Charles Golenpaul (top left), vice president of Aerovox Corp., was elected president of the Electronic Industry Show Corp., sponsor of the Electronic Parts Distributors Show. **Mauro E. Schifino** (top right), Rochester Radio Supply, was elected vice president; **Lew W. Howard** (bottom left), Triad Transformer Corp., secretary, and **Roy S. Laird** (bottom right), Ohmite Manufacturing Co., treasurer.



Pyramid Electric Co., North Bergen, N. J., announced the top winners in its recent Twist-Mount Capacitor Contest. R. Berthold, Springfield Gardens, N. Y., won the grand prize, a weekend for

DECEMBER

RADIO-ELECTRONICS

with the

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ON SALE

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himself and his wife in the Waldorf Astoria Hotel. Sid White, manager of Cross Island Electronics, the winner's distributor, received an identical prize. M. Harvey Gernsback, editorial director of RADIO-ELECTRONICS, was one of the judges in the contest.

Sylvania Electric Products broke ground for a new million-dollar addition to its Physics Laboratory in Bayside, N. Y.

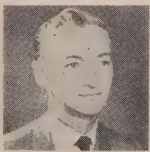
Andre Meyer, senior partner of Lazard Freres & Co.; **Paul M. Mazur**, partner, Lehman Bros.; and **Robert W. Sarnoff**, president of NBC, were elected new members of the Board of Directors of RCA, increasing membership from 14 to 17.

Richard D. Kennedy, advertising account supervisor for the General Electric Apparatus Dept., was promoted to the new post of advertising and sales promotion manager for the Receiving Tube Dept., Owensboro, Ky.

James Ewing succeeds William Klein as vice president of sales of Gabriel Co., parent company of Ward Products, Cleveland, Ohio. Klein is now vice president, merchandising. Ewing joined Gabriel from Mechanical Handling Systems, Inc.

John P. Taylor (left) is now manager, marketing plans and services, RCA Industrial Electronic Products, Camden, N. J., **Herman R. Henken**,

former advertising and sales promotion manager for RCA theatre and industrial products, succeeds him as manager, advertising and sales promotion, for industrial electronic products.



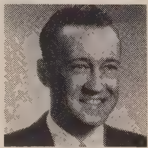
Leonard T. Donelley joined Allen B. Du Mont Labs., Inc., Clifton, N. J. as manager of component sales. He comes to Du Mont from W. L. Maxson Corp., where he was administrative assistant to the sales manager.

C. Graydon Lloyd is the new general manager of the General Electric Specialty Electronic Components Dept., Auburn, N. Y. He was promoted from manager of engineering of the General Electric Technical Products Dept.

Rein Narma was appointed manager of the Production and Engineering Divisions of Fairchild Recording Equipment Co., Long Island City, N. Y. He will also continue to serve as chief engineer.

David G. Cowden (top left), was named manager of special-purpose tube operations for the Sylvania Television Picture Tube Division, Seneca Falls, N. Y. He had been chief of mask operations in the Color TV Tube Dept. **J. E. Schlener** (top right), merchandising



manager for the semiconductor division, is the new Eastern District sales manager of the division with headquarters in Woburn, Mass. **Bernard R. McCarthy** (bottom left) and **Marvin E. Groll** (bottom right) were appointed sales engineers for the Semiconductor Division with headquarters in Philadelphia and Woburn, Mass., respectively. McCarthy comes to the company from the New York Transit Authority and Groll was formerly an electronic tube sales engineer for Sylvania.

Jack K. Poff, Jobber Division sales manager for Pyramid Electric Co., was elected a director of National Electronic Plastics Inc., Matawan, N. J.

Donald Wells and **Lynn Lockwood** joined Finney Co., Bedford, Ohio, from Welco Antenna Co. Wells will direct the Finco Models Unlimited Research Program and Lockwood will be a special factory representative. **Richard Linnert**, a well known television sales engineer, joined the company as special sales engineer.

Matthew James Leonard (left) is vice president, customer relations, Hycon Manufacturing Co., Pasadena, Calif. He joined the company from Hughes


Aircraft Co. **O. H. Mackley** was appointed vice president and general manager of Hycon Electronics, a subsidiary. He was technical services manager of the former Military Electronic Division and served as manager of the subsidiary since last March.

Robert J. Reigel was elected vice president in charge of sales for Adorn Plastics Specialists Inc., Chicago. END

Patents

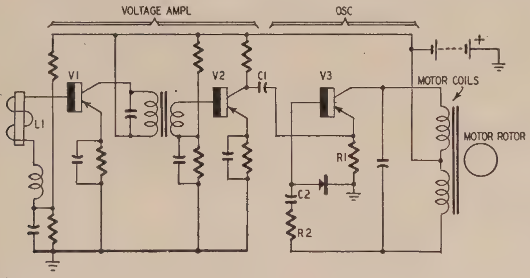
CORDLESS CLOCK

Patent No. 2,786,972

Theodore Dreier, Niskayuna, N. Y., and Ira A. Terry, Ashland, Mass. (Assigned to General Electric Co., Inc., New York).

This battery-powered clock uses a transistor circuit to produce enough alternating power to operate its motor. The frequency of the power is controlled by and synchronized with a small alternating voltage obtained from the stray fields that exist near low-frequency commercial power lines.

Pickup coil L1 provides a means of obtaining energy from stray fields produced by power lines in the walls. The first two stages amplify the induced 60-cycle signal. The third stage operates as a 60-cycle oscillator. Output from V3's collector is applied across one of the motor coils through a circuit including the battery, resistor R1 and transistor V3. The other motor coil is closely coupled to the first and provides feedback to V3's base through R2 and C2.



The frequency of oscillation is stabilized at 60 cycles by the coupling capacitor C1 between the collector of V2 and the emitter of V3. Circuit components are selected so the natural frequency of the oscillator is substantially 60 cycles. Even upon failure of commercial power the clock continues to operate at approximately the proper rate.

SUPERREGENERATIVE RECEIVER

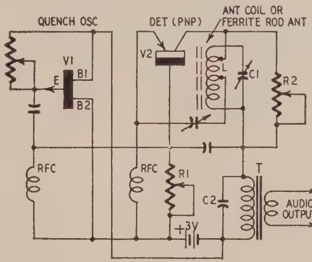
Patent No. 2,792,494

Jerome J. Suran and Woo Foung Chow, Syracuse, N.Y. (Assigned to General Electric Co.)

This is a good example of the simple, highly sensitive circuits that may be designed with modern transistors. It is a superregenerative receiver requiring only a 3-volt battery. One transistor (V2) operates as detector, the other as a separate quench oscillator (V1). V1 is a Unijunction *n-p* transistor. See "Using the Unijunction," July, 1957, page 91, which described a *p-n* Unijunction. It will suffice to say here that both transistors are inherently regenerative and show a negative resistance when connected as in the diagram.

The ultrasonic frequency from the oscillator is developed across R1, which impresses it upon the regenerative detector. The carrier tank is L–C1, tapped for Hartley operation. R2 controls the tank's Q which, if too high, results in critical tuning.

T is a matching transformer for headphones or amplifier and loudspeaker. C2 bypasses the quench frequency.



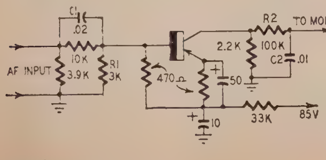
With careful design, a gain of 53 db may be obtained from this simple circuit on the broadcast band.

MODULATION CONTROL

Patent No. 2,759,052

Angus A. Macdonald, Hinsdale, and Robert C. Baltezore, Bellwood, Ill., and William J. Parks, Fort Wayne, Ind. (assigned to Motorola, Inc., Chicago, Ill.)

In a phase-modulation transmitter, the carrier frequency deviates in proportion to both *amplitude* and *frequency* of the modulating signal. This means that a low-amplitude high-frequency signal can overmodulate just as a low-frequency high-amplitude can. This transistor circuit provides suitable clipping to prevent overmodulation.



The modulation signal is differentiated by R1–C1. This produces a voltage output that varies with the rate of change of signal. For example, a higher modulating frequency generates a higher voltage than one of lower frequency, when both have the same amplitude. (The grounded-emitter CK721 is designed for symmetrical clipping at 0.7 volt.) Transistor output is integrated by R2-C2 which compensates for the previous differentiation. The signal is now impressed on the modulator.

The differentiator takes care of the frequency effect on phase modulation. Since output voltage depends upon frequency, the higher-frequency components will have reduced effect on the modulator (after clipping). No voltage higher than 0.7 appears at the modulator. If the latter is correctly designed, the carrier cannot be overmodulated regardless of modulating frequency or amplitude.

SOLAR BATTERY CHARGER

Patent No. 2,780,765

Daryl M. Chapin, Basking Ridge, Calvin S. Fuller, Chatham, and Gerald L. Pearson, Bernards Township, Somerset County, N.J. (assigned to Bell Telephone Labs., Inc. New York, N.Y.)

Solar cells have been used to power transistor radios and perform other light duty. An even more useful application is to charge a battery, so that power may be made available during the night or on dark days. The cells described here are highly efficient so that maximum power is delivered to the charging battery.

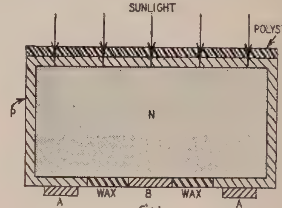


Fig.1

Each cell is a p-n junction, formed of n-type silicon with boron diffused to make a p-type border around it (Fig. 1). The p material is only 0.1 mil thick to permit light to fall onto the junction itself. Two metal terminals (A) are electroplated to each end of the p material to lower lead resistance. A single lead (B) is connected to the n material. Wax seals off the cell and reduces leakage between A and B. A polystyrene layer reduces reflection on the side facing the light source.

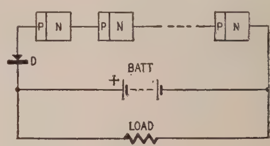


Fig.2

Each cell made in accordance with the preceding supplies an open circuit voltage of 0.52 volt, and each is capable of delivering 55 watts per square meter of surface. To charge a battery, a group of cells is connected in series (Fig. 2). Diode D permits easy flow in the *charge* direction and prevents battery discharge into the cells. END

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technical Literature

ELECTRONIC COMPONENTS GUIDE. Comprehensive data on IRC's complete line of resistors and other electronic components are presented. — **International Resistance Co.,** 401 N. Broad St., Philadelphia 8, Pa.

COAXIAL CABLES AND CONNECTORS, *microminiature.* Complete data, including actual-size photographs of this manufacturer's line, are presented in a handy 1957 34-page catalog.—**Microdot, Inc.,** 220 Pasadena Ave., S. Pasadena, Calif.

THIS IS HIGH FIDELITY, *revised edition.* In its 16 colorful pages, high-fidelity reproduction of voice and music is carefully explained—**Allied Radio Corp,,** 100 N. Western Ave., Chicago 80, Ill. 10c.

PANEL-MOUNTING INSTRUMENTS, *catalog 57-110,* lists manufacturer's line of ac vtvm's, dc vtvm's, special models and power supplies. It is illustrated throughout.—**Trio Laboratories, Inc.,** 4025 Merrick Rd., Seaford, N. Y.

ADJUST-A-CONE SPEAKERS are found in this manufacturer's pamphlet. Replacement, outdoor, PA, intercom, rear-seat auto and high-fidelity types are listed.—**Quam-Nichols Co.,** Marquette Rd. and Prairie Ave., Chicago 37, Ill.

ROD AND SHEET PLASTICS *for Electronics* are the subject of a 17-page brochure, containing technical data sheet for each product.—**Emerson & Cuming, Inc.,** 869 Washington St., Canton, Mass.

PLASTIC TUBULAR CAPACITOR. *Engineering Bulletin BTS* describes a plastic, tubular capacitor with single-ended design for printed circuits. — **Pyramid Electric Co.,** 1445 Hudson Blvd., N. Bergen, N.J.

TANTALUM-FOIL CAPACITOR, *bulletin 152* discusses the characteristics of such capacitors covering the applications and limitations of polar and nonpolar types of tantalum-foil electrolytics.—**Ohmite Mfg. Co.,** 3655 Howard St., Skokie, Ill.

RESISTORS, *bulletin P-4* contains detailed data on construction design, applications, dimensions, ranges, ratings, tolerance of type PW-20, 20-watt resistors. *Bulletin G-1b* lists similar information for type MV, high-voltage resistors. *Bulletin P-2c* covers RW-5, PW-7 and PW-10 resistors. *Bulletin A-3a* details type 2W rheostat potentiometers.—**International Resistance Co.,** 401 N. Broad St., Philadelphia 8, Pa.

HUM AND SHIELDING *Data Sheet No. 129* with 14 photos with captions descriptively illustrates the wrapping of

audio transformers, chokes and other square or rectangular components to prevent magnetic hum. — **Perfection Mica Co.,** Magnetic Shield Div., 1322 N. Elston Ave., Chicago 22, Ill.

LINEAR TRANSDUCERS, *Handbook No. R-50.* Explains the theory and application of Atcotran differential transformers. Basic theory, special design considerations and typical circuits are among the aspects covered.—**Automatic Temperature Control Co., Inc.,** 5200 Pulaski Ave., Philadelphia 44, Pa.

MORSE-TO-TELEPRINTER *Code Converter Trak Model CMP-16,* a 14-page folder, describes in abbreviated form the characteristics of each section of this equipment. Page printer, high-speed punch, recorder, matrix, bias control and receiver sections are covered.—**CGS Laboratories,** 391 Ludlow St., Stamford, Conn.

MULTIPURPOSE CRIMPING TOOLS, their use and performance, are described in an illustrated leaflet.—**Electrix Terminals & Connectors, Inc.,** 990 E. 67 St., Cleveland 3, Ohio.

CATALOG SHEET G-110 contains data on five pulse transformers, a 60-cycle stroboscope, a resistor kit, Labmarkers for generating time markers and Labcases, plug-in type housings for 3- and 4-terminal networks. — **Berkshire Laboratories,** 568 Bank Village, Greenville, N.H.

INSTRUMENTATION, digital and analog. *Catalog C-704* lists this manufacturer's line of such instrumentation. Direct-reading counters, frequency meters, nuclear scalers and count-rate meters are presented.—**Beckman/Berkeley Division,** 2200 Wright Ave., Richmond, Calif.

TRANSFORMERS AND COILS are illustrated and described in the 24 pages of *Catalog 630.* Among the items listed are antenna coils, audio transformers, chokes, variable capacitors, filters, photo-flash transformers, ratio detectors, transistor components and yokes. —**Thordarson-Meissner Mfg. Co.,** 7th and Belmont Ave., Mt. Carmel, Ill.

CONVERTER CATALOG 557 presents an entire line of dc to ac converters. Complete specifications along with illustrations are given for each converter. A list of the manufacturer's representatives, performance charts, converter selector chart for tape recorder applications and installation instructions are also included.—**Carter Motor Co.,** 2711A W. George St., Chicago 18, Ill.

LIST OF FM STATIONS in the United States and Canada is presented in a 10-page booklet. Information with each station includes city, call letters, channel number, frequency, power, antenna height, latitude, longitude and network affiliation.—**Audiocraft Magazine,** Publishing House, Great Barrington, Mass. 50c.

STEREOPHONIC SOUND is described in a colorful 16-page booklet. An illus-

TECHNICAL LITERATURE *(Continued)*

trated article explains what is meant by stereophonic sound and how it is realistically reproduced by stereophonic home music systems. A catalog section lists complete specifications and operating characteristics of this manufacturer's line.—**Ampex Audio, Inc.**, 1020 Kifer Road, Sunnyvale, Calif.

POWER POINTS DIGEST, *Vol. 12. No. 4*, a 2-color 16-page booklet, describes Vacu-Flo cooled electric plant applications.—**D. W. Onan & Sons**, University Ave. at 25th St., Minneapolis 14, Minn.

THERMOSETTING ELECTRICAL TAPES. A 4-page 2-color booklet outlines the properties, recommended application procedures and advantages of Scotch brand electrical tapes with thermosetting adhesive.—**Minnesota Mining & Mfg. Co.**, Dept. D7-207, 900 Bush St., St. Paul, Minn.

RECORDING TAPE. An illustrated brochure, *How to Choose the Right Recording Tape*, offers general information on magnetic recording tape, and covers also recording characteristics and the elements, Mylar and cellulose acetate, which govern tape's physical characteristics. — **Reeves Soundcraft Corp.**, 10 E. 52 St., New York, N.Y.

Any or all of these catalogs, bulletins, or periodicals are available to you on request direct to the manufacturers, whose addresses are listed at the end of each item. Use your letterhead—do not use postcards. To facilitate identification, mention the issue and page of RADIO-ELECTRONICS on which the item appears. UNLESS OTHERWISE STATED, ALL ITEMS ARE GRATIS. ALL LITERATURE OFFERS ARE VOID AFTER SIX MONTHS.

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Television News	1931

Some larger libraries still have copies of ELECTRICAL EXPERIMENTER on file for interested readers.

In November, 1923, *Science and Invention* (formerly *Electrical Experimenter*)

World's Energy from Atomic Force.
Hearing Through the Teeth, (The Osophone) by H. Gernsback.
Students Learn Code While Asleep, by S. R. Winters.
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Broadcast Relay on 100 Meters, by Howard Allen Duncan.
Cockaday Four-Circuit Tuner, by Leroy Western.
Experimental Circuit Panel, by R.D.B. Washburne.
Good Single Circuit Receiver, by H. Allen Duncan.
Crystal Detectors, by A. P. Peck.

Books

TRANSISTOR APPLICATIONS, Vol. II. Raytheon Manufacturing Co., 55 Chapel St., Newton 58, Mass. 58 pages, 8½ x 11 inches. 50c.

This edition covers more general ground than the previous one. It includes hints on lab techniques, shop practice and basic transistor theory. There are construction articles on radio receivers, ham equipment, home broadcasters, burglar and fire alarms. Printed circuits, use of sun batteries and wiring precautions are also discussed. —*IQ*

ELECTRONIC ENGINEERING, By Samuel Seely. McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36, N. Y. 525 pages 6 x 9. $8.

This book analyzes basic circuits used in communications, computers and control instruments. Both physical and mathematical explanations are clearly stated, with many examples worked out in the text. Major chapter headings include amplifiers, oscillators, sweep generators, rectifiers, tubes and transistors. Feedback, frequency response and other important topics are adequately covered. An excellent study and reference for designers, engineers and technicians.—

GETTING STARTED IN AMATEUR RADIO, by Julius Berens, W2PIK. John F. Rider, Publisher, Inc., 116 W. 14th St., New York 11, N. Y. 5½ x 8½ inches, 136 pages. $2.40.

Not many years ago, would-be hams had to grope their way to a license for there was little information available unless they knew a friendly licensed amateur. Today, it is possible for one to become an amateur with a reasonable amount of effort. Here is a book that any ham would gladly recommend to beginners. It tells the whole story—how to study the code, how to use a key, elementary radio theory and study questions. The more important FCC regulations are printed at the back of the book.

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TRANSISTOR CIRCUIT ENGINEERING, edited by Richard F. Shea. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. 5¾ x 9 inches, 468 pages. $12.

This is an advanced transistor book prepared by a staff of G-E engineers. It shows how to design audio and video

amplifiers, oscillators and modulators as required. Bias and stabilizing networks receive full attention, and there are many practical examples. Formulas and graphs are often referred to. The final chapters show how these basic circuits are put to work in radio and TV receivers, filters, converters and power supplies.—*IQ*

ESSENTIAL CHARACTERISTICS, Tube Sales Section, General Electric Co., Schenectady, N. Y. 5½ x 8½ inches, 228 pages. 75c.

This spiral loose-leaf manual lists every tube likely to be encountered in radio and TV receivers. It shows the type of service, electrical characteristics and capacitance, besides physical data. Basing connections appear on the same page.

Besides ordinary receiving tubes, the manual lists the special 1600, 5000, 6000 and 9000 series. Prototypes like 5U4-GB, 6AQ5, 6SN7, 12AX7, etc. appear again at the end of the book with average characteristics in graph form. Several circuit diagrams of receivers, amplifiers and power supplies are also included.—*IQ*

ELEMENTS OF COLOR IN PROFESSIONAL MOTION PICTURES. Society of Motion Picture & Television Engineers, 55 W. 42 St., New York 36, N. Y. 6 x 9 inches, 104 pages. $3.50.

Color photography is a highly specialized and complex field that embraces both art and science. Thus it often happens that studio artists and technicians know much about their own particular phase, but little of what is going on in other departments. For them, a special committee of the SMPTE has prepared this book. In nonengineering terms it tells how to plan and process color films. Many color photos illustrate the theory of color, several of the more important commercial processes and the results of improper handling. One chapter deals with problems of TV color films and kinescope recordings.

TRANSISTOR CIRCUITS, by Rufus P. Turner. Gernsback Library, Inc., 154 W. 14th St., New York 11, N. Y. 5½ x 8½ inches, 160 pages. $2.75.

A variety of useful, practical and experimental transistor circuits are described here. They are presented in a way that gives maximum benefit and information to those wishing to duplicate the device. Thus each schematic shows all component values. Several amplifiers are accompanied by their frequency response curves. Coil tables give winding data for several oscillators. Surface-barrier transistors and zener diodes are represented in addition to the common p-n-p and n-p-n transistors.

Largest chapters are those devoted to audio amplifiers, radio receivers,

control devices and test instruments. Here one will find data to assemble complementary and direct-coupled amplifiers, superhets, relays, alarms, signal injectors, dip oscillators, light meters and many others. Among other chapter headings are amateur devices, rf amplifiers and power supplies. This book is a saver of time and energy for all who work (or play) with transistors.

TRANSISTOR MANUAL, second edition. Semiconductor Products Dept., General Electric Co., 1224 W. Genesee St., Syracuse, N. Y. 5½ x 8½ inches, 112 pages. 50c.

Having exhausted its first edition, this handy manual goes into the second. It meets the needs of technicians and hobbyists who wish to keep up with latest developments in transistors for radio, test equipment and gadgets. Complete specifications of nearly 50 G-E transistors are given. It also contains diagrams of many amplifiers, portable radios and hi-fi circuits. A table lists all Jetec transistor types with characteristics.

The manual begins with the theory of semiconductors and circuits. It shows how to bias properly, provide stabilization and couple multiple stages. Tone controls, preamplifiers, reflex if stages, converters and switches are drawn. Of course, the new Unijunction is described and many uses appear. Pulse circuits are also given considerable attention.

TV TROUBLE TRACER, Vol. 6. Harry G. Cisin, Amagansett, N. Y. 5½ x 8½ inches, 45 pages. 50c.

The sixth volume of this popular handbook can save hours of time and labor. It covers many portable TV sets of all manufacturers. Detailed drawings show the tube layouts of the various sets. Each tube is also marked with a code letter; for example, a vertical output tube is marked with a V for vertical. Forty common difficulties are illustrated by a test pattern showing the fault. A discussion of various faults that may be at the seat of the trouble is also given. Added help is given by indicating sets with selenium rectifiers and series circuits. Also contains tube locations of the most recent 1957 RCA TV sets, portables and standard models.—*LS* END

CORRECTION

The Patents column on page 140 of the September issue contains a queer typographical error which transposes complete sentences from two different items. The last sentence in the second paragraph of the item "Volume Control Circuit" was transposed with the last sentence of the first paragraph of the item "Transistor Power from Local Radiation."

We thank Robert Sparkes, of Toronto, Ont., for this correction.

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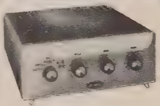

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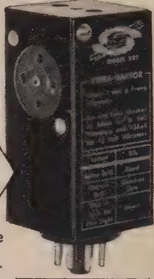

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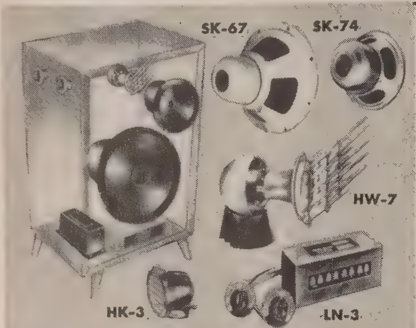


3 WAY SYSTEM WITH 15" WOOFER . . . 8" MID-RANGE SPEAKER . . . HORN TWEETER . . . CROSSOVER NETWORK

• 15-INCH WOOFER WITH 31.5 OZ. MAGNETIC (SK-67) • 8-INCH MID-RANGE SPEAKER (SK-74) • NEW HIGH FREQUENCY ACOUSTICAL LENS TWEETER (HW-7) • 3-WAY CROSSOVER NETWORK (LN-3)

Lafayette presents this outstanding 3-way speaker system designed for the high fidelity enthusiast who desires performance formerly possible in multi-speaker systems costing many times this price. You won't believe your ears when you hear the superb reproduction throughout the entire audio spectrum. The SK-67 15" woofer provides phenomenal bass response, the SK-74 8" speaker delivers full bodied, mid-range frequencies, and the HW-7 high frequency acoustical lens tweeter faithfully reproduces the highest audible frequencies. Crossover points at 350 and 5000 cycles are provided by the LN-3 3-way inductance-capacitance network with continuously variable presence and brilliance controls that adjust tone balance to personal taste. Shpg. wt., 25 lbs.

SY-93. Complete System as listed above .... Net **55.50**

2 WAY SPEAKER SYSTEM 40-16,000 CYCLES

• 25 WATT WOOFER • CROSSOVER NETWORK • IMPORTED HI-FI TWEETER • LEVEL BRILLIANCE CONTROL

This 2-way speaker system is another excellent buy for the moderate purse. It is basically the same as the SY-85 system described at the top of the page, but incorporates the deluxe SK-68 speaker with 21.5 oz. Alnico V magnet. This results in more efficient reproduction and extension of the lower register. Complete system includes the SK-68 12" 25 watt woofer, HK-3 cone type tweeter and LN-2 crossover network with level-brilliance control. Range of system 35-16,000 cycles. Shpg. wt., 18 lbs.

SY-87—Complete System .... Net **27.50**

6 TRANSISTOR SUPERHET RECEIVER KIT

- 100% SUBMINIATURIZED
- SENSITIVE, SELECTIVE, STABLE
- PUSH-PULL OUTPUT — PLENTY OF POWER
- AN INCOMPARABLE VALUE

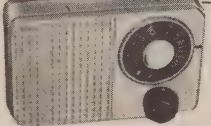
The Lafayette KT-119 6 Transistor Superhet Transistor Kit provides superior commercial quality with maximum sensitivity, selectivity and stability. The circuit features 6 selected transistors and crystal diode, a specially matched set of 3 IF's, Oscillator coil, high Q loop, and audio transformer coupling. Has efficient 2¾" speaker and earphone jack for private listening. Complete with all parts, transistors, prepunched chassis and easy to follow step-by-step instructions. 6½" x 3½" x 1½". Shpg. wt., 3 lbs.

KT-119—Complete Kit—Less Case & Battery .... Net **29.95**

BATTERY RCA VS300...... Net **1.23** BURGESS P6.............. Net **.77**

MS-339—Sturdy, attractive brown leather case with carrying strap for KT-119. Shpg. wt., 1 lb. .... Net **2.95**

MS-366–Sensitive matching earphone Net **1.29**



3 TRANSISTOR SUPERHET POCKET RADIO KIT

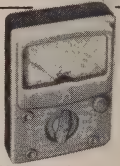
- A TRUE POCKET SUPERHET RECEIVER
- NO EXTERNAL ANTENNA
- NO EXTERNAL GROUND

A remarkable sensitive, super-selective pocket superhet receiver with astonishing performance over the complete broadcast band. Uses 2 high-frequency and one audio transistor plus efficient diode detector and features 2 specially matched IF transformers for maximum power transfer. The components are housed in a professional looking beige plastic case. The receiver's appearance enhanced by attractive maroon and silver station dial. Sensitive built-in ferrite antenna eliminates need for external antenna. A designer's dream in a true pocket superhet receiver! Complete with all parts, transistors battery, case, dial and easy to follow step-by-step instructions. 4⅛" x 2⅝" x 1-1/16". Shpg. wt., 1 lb.

KT-116—Complete Kit, less earphone .... Net **16.95**

MS-260—Super Power Dynamic Earphone .... Net **3.95**

NEW POCKET AC-DC VOM MULTITESTER



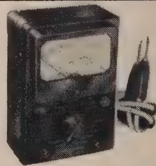
2,000 ohm per volt sensitivity on both DC and AC
160 ua 3" METER 1% PRECISION RESISTORS
SILVER CONTACT SELECTOR SWITCH
FULL SCALE RANGES

D.C. Volts: 0-10; 0-50; 0-500; 0-1000 Volts—**A.C. Volts:** 0-10; 0-50; 0-500; 0-1000 volts—**D.C. Current:** 500 ua and 500 ma—**Resistance:** 0-10K; 0-1 Meg—**Decibels:** —20 to +22; +20 to 36 db (0 db—0.775 V)—**Capacity:** 250 mmfd. to .2 mfd—.005 mfd to 1 mfd—**Output Ranges:** 0-10; 0-50; 0-500; 0-1000 volts.

Best Buy in America! A very accurate and sensitive VOM. This Multitester is a complete instrument (not a kit) with high quality and sensitive 160 microamp meter; 2000 ohm per volt on both AC and DC. Single selector switch, 1% precision resistors, 3" meter. Features extreme versatility, accuracy and ruggedness. In attractive plastic front panel, with metal bottom for ruggedness and shielding. First capacity range requires 50 volt AC source. Second capacity range requires 10 volt AC source. Size 4¼" x 3½" x 1⅝". Complete with test leads and batteries. Shipping weight 4 lbs.

RW-27A .... Complete **8.95**

HIGH SENSITIVITY 20,000 OHM PER VOLT DC 10,000 OHM PER VOLT AC MULTITESTER



LOOK AT THESE FULL SCALE RANGES!

D.C. Volts: 0-6; 0-30; 0-120; 0-600; 0-1200; 0-6000 Volts—**A.C. Volts:** 0-6; 0-30; 0-120; 0-600; 0-1200 Volts—**Resistance:** 0-10K; 0-100K; 0-1 Meg; 0-10 Megohms—**D.C. Current:** 0.60 Microamp; 0-6; 0-60; 0-600 Milliamps—**Decibel:** —20 to +17 db (0db—0.774V)—**Capacity:** .0001-.01; .005-.15 mfd—**Inductance:** 20-2000 millihenry—**Output Ranges:** 0-6; 0-30; 0-120; 0-600; 0-1200 Volts.

The new Lafayette high sensitivity Multitester is a complete instrument (not a kit). In addition to its unusual sensitivity of 20,000 OHMS PER VOLT ON D.C. AND 10,000 OHMS PER VOLT ON A.C., and the extraordinary number and scope of its ranges, it is packed with features that would make it cost at least twice as much if made in this country. Uses 1% precision resistors, silver contacts on selector switch, 35 ua 3" meter. Dependable, rugged and accurate. Even the test leads are heavy duty with high voltage insulation. Voltage source required for low capacity range is 120V for high range capacity and inductance scale is 6V A.C. Attractive plastic front with metal botton. Size 6¼" x 4¼" x 2½". Complete with batteries and leads. Shipping weight 4½ lbs.

RW-30A .... Singly, Each **19.95**

In lots of 3, Each **19.25**

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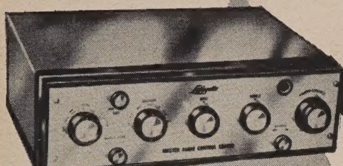


KT-300 IN KIT FORM 39.50

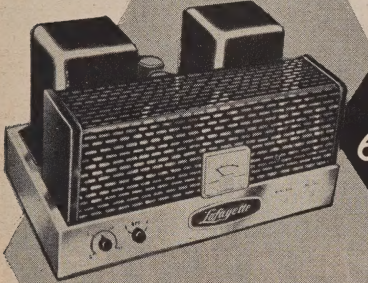
LAFAYETTE MASTER AUDIO CONTROL CENTER with BINAURAL CHANNEL AND DUAL VOLUME CONTROL.

Years Ahead of Every Other Control Unit ... Ahead In Sound ... Ahead In Styling Ahead In Design ... Ahead In Features ... Available In Kit and Wired Form

This is not only the finest hi-fi preamp characterized by unmatched features, but it has been functionally designed to keep pace with the conversion of your present hi-fi system to binaural (Stereophonic) sound. Incorporates an extra channel and dual volume control for binaural reproduction. Features include DC on all tube filaments, negative feedback in every stage, dual cathode follower output stages and latest printed circuit construction. Less than 0.09% IM distortion and less than 0.07 harmonic distortion at 1V. Hum and noise level better than 80 db below 3V. Uniformly flat frequency response over entire audible spectrum. 7 inputs for every type of phono, tuner or tape. Tasteful styling, brilliantly executed. Size 12¾ x 9⅛ x 3¾". Shpg. wt., 10½ lbs.

KT-300—Lafayette Master Audio Control Kit Complete with cage and detailed assembly instructions. .... Net **39.50**

LT-30—Same as above completely wired and tested with cage and instruction manual. Net **59.50**



KT-400 IN KIT FORM 69.50

DELUXE 70 WATT BASIC AMPLIFIER

- **Conservatively Rated At 70 Watts** • **Ultra-Stable** • **Variable Damping**
- **Metered Balance And Bias Adjust Controls** • **Available In Kit And Wired Form**

Here's ultra-stability in a 70 watt basic power amplifier employing highest quality components conservatively rated to insure performance and long life. Features matched pair KT 88's and wide range linear output transformer, variable damping control, meter for bias and balance and chrome plated chassis. Frequency response 10-100,000 cps ± 1db. Hum and noise 90db below full output. IM distortion less than 1½% at 70 watts, less than 0.3% below 30 watts. Harmonic distortion less than 2% at 70 watts from 20 to 20,000 cps ± 1db. Output impedance 4,8 and 16 ohms. Handsome decorative cage perforated for proper ventilation. Size 14½ x 10 x 7⅜" including cage and knobs. Shpg. wt., 40 lbs.

KT-400—Lafayette 70 watt Deluxe Basic Amplifier Kit complete with cage and detailed assembly instructions. .... Net **69.50**

LA-70—Same as above completely wired and tested with cage and instruction manual. Net **94.50**

LA-22 WIRED 12 WATT AMPLIFIER 33.50 WITH CASE

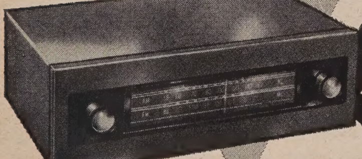
NEW! MATCHED TUNER AND AMPLIFIER

LAFAYETTE 12 WATT AMPLIFIER WITH CASE

Complete 12 Watt Power Amplifier with Built-In Preamplifier-Equalizer Brings Real Hi-Fi at Low Cost

The Lafayette LA-22 amplifier features wide range frequency response and low hum and distortion. Utilizes premium quality EL84 tubes in a pentode connected balanced output circuit. Five inputs provided for every type of phono cartridge, tuner, tape head, TV, crystal phono, etc. Function selector and equalization switch give instant choice of proper equalization for all types of records and tape head. Loudness control approximates Fletcher-Munson characteristics for tonal balance at low listening levels. Bass and treble controls afford wide variation of cut or boost of highs and lows. Frequency response 30-20,000 cps ± 1 db. Sensitivity, for full output ½ V on tuner, crystal or aux., 8 mv for magnetic phono or tape head. I.M. Distortion less than 1½%. Attractively finished to harmonize with both modern and traditional decor, its appearance matches the Lafayette LT-25 tuner. Size 13⅜" x 6⅜" x 4½". Shpg. wt., 15 lbs.

LA-22 Amplifier, Complete With Removable Case........ Net **33.50**



LT-25 WIRED FM-AM TUNER 49.50 WITH CASE

LAFAYETTE HI-FI FM-AM TUNER WITH CASE

- **Armstrong Circuit With Limiter** • **Foster-Seeley Discriminator**
- **Temperature Compensation and AFC** • **Custom Styled**

Like its matching amplifier, the Lafayette LT-25 FM-AM tuner is a most unusual value with outstanding specifications and superlative performance. Circuit features temperature compensation for stability and low drift, AFC to "lock-in" the station and AFC defeat for precision tuning of weak stations. Inertia flywheel makes tuning smooth. High selectivity and sensitivity. Meets FCC requirements for radiation. Distortion less than 1% on FM and AM. Frequency Response 20-20,000 cps ± 1 db on FM; 20-5000 cps ± 3 db on AM. Hum level 60 db below 100% modulation. Attractively finished to match the LA-22 amplifier. Comes complete with removable cover, with provisions for mounting either in cabinet or on panel. Size 13½" x 8-3/16" x 4½". Shpg. wt., 15 lbs.

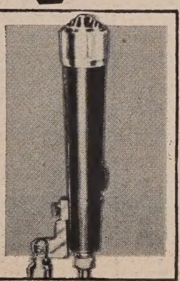
LT-25 FM-AM Tuner, Complete With Case........ Net **49.50**

NEW "DYNA-SLIM" MICROPHONE

- **HIGH IMPEDANCE — 50,000 OHMS**
- **ON-OFF SWITCH**
- **"QUICK-SLIP" ADAPTER**

New dynamic, high output microphone with all the features of "mikes" costing 3 times Lafayette's price! Output level —55db. Smooth response from 60 to 10,000 cycles. Omnidirectional head. External on-off switch. Slips on or off stand adapter in a wink. Standard ⅝" — 27 adapter permits tilting mike for multi-angle use. Satin black and chrome finish. Complete with detachable cable and connector. 8" long, 1¼" max. dia. tapered panel. Shpg. wt., 2 lbs.

PA-43 .... Net **6.95**



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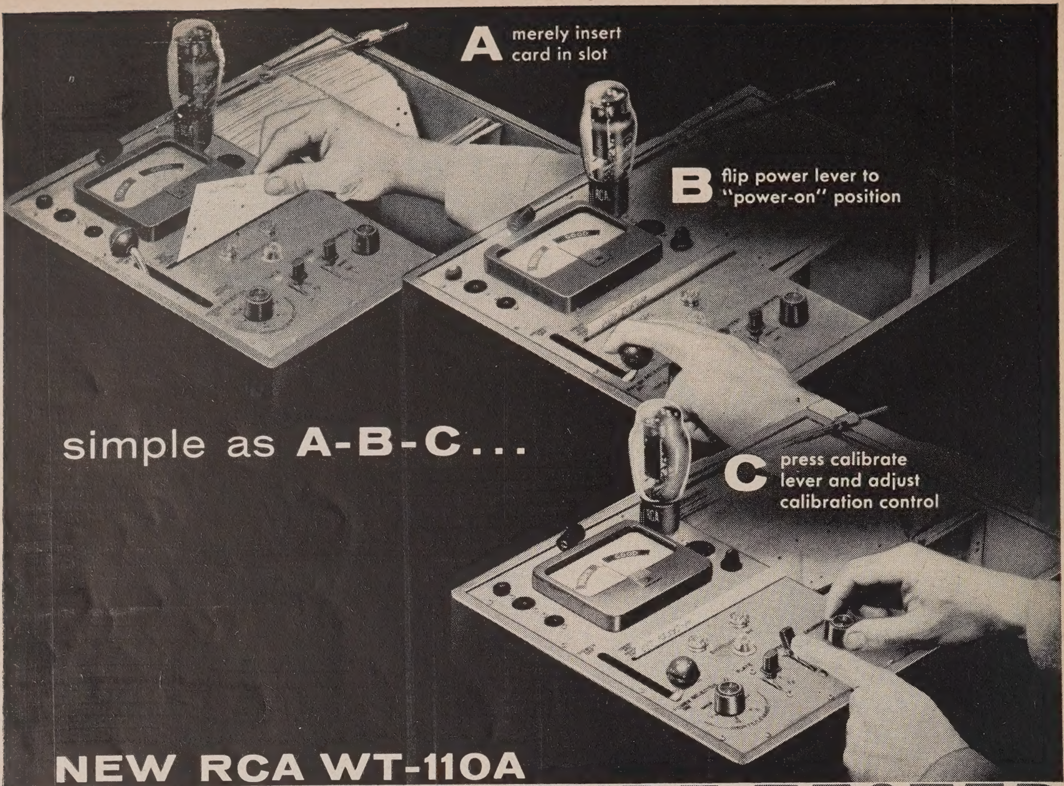
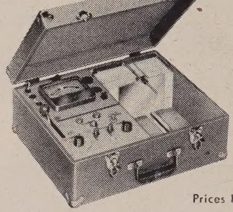


AUTOMATIC TUBE-TESTER

means more service profits!

Dollar for dollar, feature for feature, you'll find RCA's WT-110A the fastest, most accurate automatic punched-card tester you can buy today. It's a virtually *obsolescence-proof design* ...from the exclusive RCA 700-card capacity magazine file that always keeps the pre-punched cards in type number sequence, to the fully automatic circuit setup (including *all* operating voltages) and the easy, do-it-yourself punch card accessories available to keep the tube-card file up-to-date!

See and test the WT-110A at your local RCA Distributor. Prove to yourself what a boost in business, prestige, profits the RCA-WT-110A can mean!



All this for $199.50

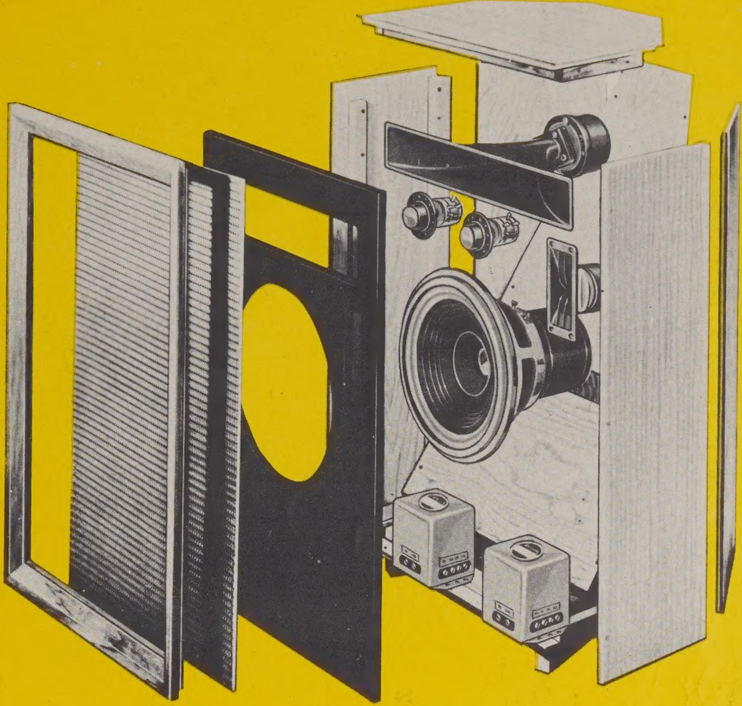
USER PRICE (Optional)
Prices higher in Hawaii and Alaska

- automatically sets up socket connections, and all operating voltages such as heater, signal, plate and screen voltages, and bias (both fixed and cathode).
- checks tubes for transconductance, gas, shorts, and leakage between elements.
- automatically selects correct conditions from 220 possible combinations of heater voltage (from 0.1 volt to 120 volts) at currents up to 4 amps., 10 bias voltages and 11 values of cathode resistors.
- tubes, such as rectifiers, tested under heavy load currents up to 140 ma *per plate*.
- high-and-low sensitivity ranges for leakage tests.
- 12-volt plate and screen supply for testing new auto-radio tubes.
- meter protected against burnout.
- test card provided for checking instrument.
- 239 pre-punched cards supplied with instrument cover 95% of currently active TV tubes. Pre-punched accessory cards available.
- active card magazine capacity—350; storage capacity—350...a total capacity of 700 cards.

RCA®

TEST EQUIPMENT
RADIO CORPORATION OF AMERICA
Electron Tube Division, Harrison, N. J.

FOR HI-FI ON A BUDGET, FOLLOW THE ELECTRO-VOICE BUILDING BLOCK PLAN



Start with your basic speaker and improve your compatible E-V high-fidelity system one economical step at a time by adding Electro-Voice Speaker Building Blocks.

Here, we've started with an SP12—12-inch coaxial driver. Later, you add BB2—a T35 very-high-frequency driver, X36 crossover and AT37 level control with wiring harness. BB2, Net $50. Still later, augment with the BB4—to smooth and disperse treble range, it includes T25A treble driver, with 8HD horn, a second crossover—800-cps X8—and a second AT37 level control with wiring harness. BB4, Net $114.

Build Your Own E-V Speaker Enclosure with a Pre-Cut, Pre-Cleated *'Do-It-Yourself'* Kit

There's no thrill like building your own speaker enclosure! Economize on your hi-fi system without sacrificing quality by assembling an E-V knock down kit of Korina plywood. Korina is of highest quality, naturally light in color, harder than mahogany, allows finishing to match any shade. There are seven models to choose from.

Shown dis-assembled is E-V's KD6 kit. Assemble it and you have a duplicate of our factory-built ARISTOCRAT enclosure of folded horn corner design for use with 12-inch drivers or separate multi-way systems. KD6, Net $39.

For all the facts about Electro-Voice 'Listeneered' high-fidelity components, see your distributor and write for complete details.

Electro-Voice®

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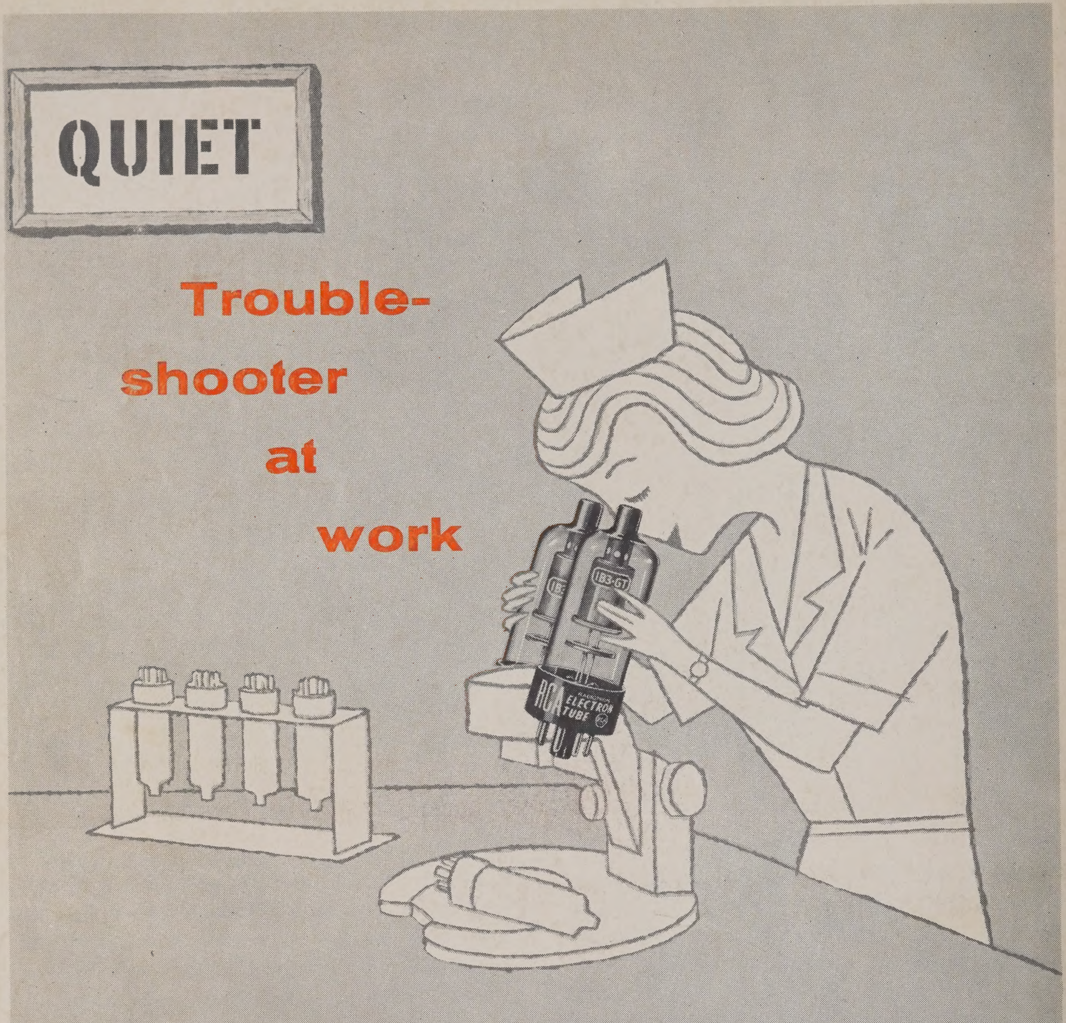

Trouble-shooter at work

Here's how Microscopic Inspection by RCA helps reduce costly callbacks...

A bad tube, or a potential trouble-maker—can it get by this gal? Not likely. She's part of the specially trained RCA group of inspectors whose important job it is to find trouble and help prevent it from happening *to you*.

RCA Quality-Control Procedures include MICROSCOPIC INSPECTION OF POPULAR TV RECEIVING TYPES! These types are closely examined for possible poor welds, weld splatter, bad crimps, damaged stems, improper assembly, and many other factors that can affect top quality, long-term performance. Though the tubes may pass all electrical tests, such defects could slip by and mean the difference between a profitable service call and a costly callback.

You gain valuable assurances from this *extra* care: (1) that popular TV receiving types shipped to RCA Tube Distributors have had the *extra* benefit of the MICROSCOPIC INSPECTION PROGRAM and (2) that you can always service your customers with the confidence that RCA TV Receiving Types are top quality replacement tubes.

When you order—tell your distributor "RCA only" and watch your profits grow.

RCA®

RECEIVING TUBES

RADIO CORPORATION OF AMERICA

Tube Division, Harrison, N. J.